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Bulletin

of the

Torrey Botanical Club

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A revision of the subgenus Hugelia of the genus Gilia (Polemoniaceae)

THOMAS CRAIG

(CONCLUDED)

2c. **Gilia virgata** var. **sapphirina** (Eastwood) Macbride, Contrib. Gray Herb., n.s., **49**: 58. 1917. *Gilia sapphirina* Eastwood, Bot. Gaz., **38**: 71. 1904; *Navarretia virgata var. sapphirina* (Eastwood) Brand, Pflanzenreich IV, **250**: 165; *Hugelia virgata var. sapphirina* (Eastwood) Jepson, Man. Fl. Pls. Calif., 793. 1925; *Navarretia virgata* Sub. Sp. *gymnocephala* Brand l.c., in large part; *Navarretia virgata var. oligantha* Brand l.c.

Plants erect 7–35 cm. tall, loosely paniculately branched from base; branches slender, sparsely leaved, commonly viscid-glandular; leaves 1–5 cm. long, commonly simple and sub-terete, the uppermost occasionally with 2 very short bristle-tipped divisions at base; flowers solitary, sessile, or pedicellate or borne in 2–4-flowered clusters; bracts broadly ovate and 3-lobed or membranous on either side of broad green rib, thinly pilose and commonly somewhat glandular, 3–8 mm. long; calyx 8 mm. long, campanulate, or tubular, glandular puberulent and viscid, not at all lanate; corolla regular to slightly irregular, commonly about 12 mm. long; lobes sapphire blue, elliptical 6–7½ mm. long, rarely twice as long as tube; tube yellow 4 mm. long; stamens 7–8 mm. long; anthers oblong, sagittate 2–2½ mm. long.

Type locality, San Jacinto Mts., Riverside Co., California. Representative material studied, CALIFORNIA: San Bernardino Co., Sugar Loaf Mt., *Munz* 10,760 (P); Santa Ana River 6500 ft., *Munz* 6157 (P); Bear Valley, *Pierce* in 1922 (P); Big Meadows, *Feudge* 1216 (P); Mission and Fish Creek divide, *Munz* and *Johnston* 8526 (P); Santa Ana River 8100 ft., *Munz* and *Johnston* 8633 (P). Los Angeles Co., Swartout Canyon, *Hall*, 299 (C). Riverside Co., Strawberry Valley, *Hall* 329 (C); San Jacinto Mts., *Hall* 2635 (C, P), *Trask* in 1903 (C.A.); Strawberry Valley, *Hoffmann* in 1929 (C.A.); Idylwild, *Spencer* 1657 (P); Hemet Valley, *Munz* 5973 (P); Hemet, *Wilder* 959 (C) approaches *dasyantha* in size of flower clusters. San Diego Co., Palomar Mt., *Meyer* 489 (C), *T. S. Brandegee* in 1898 (C); Witch Creek, *Alderman* 401 (C), Laguna Woods, *Cleveland* in 1885 (C); Cuyamaca Mts., *K. Brandegee* in 1906 (C, P), *K. Brandegee* in 1874 (C); Buckman Springs, *Meyer* 434 (C); Descanso, *Spencer* 918 (P); Viejas, *K. Brandegee* in 1906 (C); Warner's Hot Springs, *Buttle* in 1913 (C.A.); 10 mi. so. of Warner's Hot Springs, *J. T. Howell* 3268 (C.A.). LOWER CALIFORNIA: 9 mi. southeast of Tecate, *Munz* 9475 (P); 10 mi. north of Ojos Negros Rancho, *Wiggins* and *Gillespie* 4133 (C.A.).

[THE BULLETIN FOR OCTOBER (**61**: 345-409) WAS ISSUED OCTOBER 3, 1934]

Vars. *sapphirina* and *ambigua* form quite a distinct section of *G. virgata*, having slightly irregular corollas, with longer stamens and shorter tube, and great reduction in the size of the flower clusters. Var. *sapphirina* as intended by Miss Eastwood and as I have applied the name, refers to the large flowered, glandular form found most commonly in the San Jacinto Mts. at elevations of 5000–8700 ft. Northward var. *sapphirina* ranges through the Mts. into San Bernardino and Los Angeles Counties, where it intergrades with var. *ambigua* Jones. The following collection is typical of this intergradation: Bear Valley, *Jones* 9917 (P). Southward var. *sapphirina* ranges through the higher Mts. into Northern Lower California. These most southern examples usually show an extreme variation in the reduction in the size of the flowers and flower clusters, for occasional plants have the flowers solitary and pedicelled. To these extreme examples Brand has given the name var. *oligantha*, I do not consider them distinct enough for recognition as a variety. The most extreme example of this reduction in the size of flowers and heads is Santa Catalina Mts., Lower Calif., *Orcutt* in 1883 (C), which is possibly type material of Brand's var. *oligantha*. I have seen two doubtful collections from the low coastal areas of San Diego County: Point Loma, *Brandegee* in 1906 (C); near San Diego, 1900 ft., *Spencer* 68 (C); but apparently var. *sapphirina* is an extreme rarity at elevations below 4000 ft.

Two other sheets from Lower California, Vallederos Creek, *Brandegee* in 1893 (C); Guadulupe Creek, *Brandegee* in 1893 (C), are of special interest, for apparently they represent still another race closely related to var. *sapphirina* and var. *ambigua*, and at the same time greatly resembling *eremica* in habit. The flower corresponds very closely to collections of var. *ambigua*, especially those from the high desert plateaus of San Bernardino County. I may cite *Orcutt*, July 9, 1884, from Hanson's Ranch northern Lower Calif., as a collection of var. *sapphirina* that resembles these sheets and that indicates a close relationship to that variety.

2d. **Gilia virgata** var. **ambigua** (Jones) n. comb.; *G. floccosa* var. *ambigua* Jones, Contrib. W. Bot. **13**: 2. 1910.

Plant 10–25 mm. high, paniculately much branched, sub-glabrous to somewhat glandular; leaves 10–30 mm. long, linear and entire, or the uppermost with 2 spinose lobes at base; bracts broadly oval to orbicular 3–5-lobed; calyx 5 mm. long pilose to densely lanate, tubular; corolla pale, sapphire, or deep blue, 8–10 mm. long; lobes broadly elliptical 4–5 mm. long; stamen 4½–5½ mm. long, anthers white oblong sagittate, 1½–2 mm. long.

Type locality, Victorville (Victor), Mohave Desert, California. Representative material studied, CALIFORNIA: San Bernardino Co., 12 mi.

southeast of Victorville, *J. T. Howell* 108 (S.A.); Victorville, *Jones* in 1903 (type) (P); Mohave River district, *Palmer* 405 (C); southward from Barstow, *Jones* in 1926 (P); Box S Ranch and northward, *Jones* in 1929 (P); 2 mi. east of Deadman's Point, *Munz* 12,951 (P); Wrightwood, *Munz* and *Johnston* 11,197 (P). Los Angeles Co., 5 mi. south of Lancaster, *Munz* and *Craig* 12,953 (P); 12 mi. south of Muroc, *Munz* and *Craig* 12,926 (P); Monrovia Canyon, *Howell* 3879 (C); Lancaster, *K. Brandegee* in 1888 (C); San Antonio Mts., *Hall* 237 (C); Swartout Valley, *Munz* 7724 (P, C); Sheep Creek, *Peirson* 4128 (P); 3 mi. east of Vincent, Edge of San Gabriel Mts., *Craig* 2022 (P).

Var. *ambigua* is very much localized in the high desert plateaus and Mts. of Los Angeles and San Bernardino Counties, but there are several isolated collections from localities quite distant but ecologically similar. Inyo Co., Westgard Pass, *Hoffmann* (S.B.); Walker's Pass, *Purpus* 5391 (C). Kern Co., Buena Vista Hills, *Davidson* 580 (Ewan). Riverside Co., Aguanga, San Jacinto Mts., *Condit* in 1910. San Diego Co., Campo, *T. S. Brandegee* in 1904 (C).

Mr. Jones' use of the name *ambigua* in publication is somewhat different from his use of the name in his herbarium, which latter use is, of course, disregarded. The collection from Victor (Victorville) no. 10,011 cited first by him in the original description and consequently considered the type in this paper, is immature but representative of desert material and explains clearly the use of the name for publication. The collection from Bear Valley, San Bernardino Co., cited secondly, *Jones* 9917 is not at all typical being an intergrade near var. *sapphirina*.

3. GILIA LUTESCENS Steud., ex Benth., in D. C. Prodr. **9**: 311. 1845. *Hugelia lutea* Benth., Bot. Reg. 19: sub. t. 1622. 1833. Not *G. lutea* (Benth.) Steud. *Navarretia lutea* (Benth.) Brand, Pflanzenreich IV, **250**: 168. 1907; *Gilia floccosa* A. Gray, Proc. Am. Acad. 8: 272. 1870. (As to type.)

Plant annual, erect, 8–30 cm. high, few to many branched; stems glabrate; leaves usually narrowly linear 8–25 mm. long, rarely parted into 3 filiform segments; inflorescence white woolly 2–8-flowered; flowers bright sulphur yellow, 7–9½ mm. long, lobes almost equalling tube; stamens inserted in tube ¼ of distance below sinuses; ovules solitary in the cells.

Type locality, California, Douglas; probably near Monterey. Range, from Monterey Co. the species extends south through the hills and valleys of San Luis Obispo Co. across the north (desert) slopes of the San Gabriel Mts., to its southern limit on the east side of the Santa Ana Mts. It is very rare, at least in the southern part of its range. Representative material studied, CALIFORNIA: Monterey Co., California, Douglas (C) (probably

type collection); Nacimiento River and Gorda, *K. Brandegee* 136 (P, C); Jolon, *K. Brandegee* in 1909 (C), *T. S. Brandegee* (C). San Luis Obispo Co., Mts. north of San Luis Obispo, *Lemmon* in 1878 (C), *Lemmon* in 1896 (C), Los Angeles Co., Ravenna, *K. Brandegee* in 1889 (C), *K. Brandegee* 135 (C, P); Acton, *Hoffmann* (S.B.). Riverside Co., Santa Ana Mts., *Munz* 7103 (P, C).

G. lutescens is very closely related to *G. virgata*, especially to var. *ambigua* with which it may intergrade in Southern Calif. Because those who have been fortunate enough to see it in the field, regard it as a distinct species, I have chosen to regard it as such. As possible intergrades I cite the following collections: Temescal Canyon, *Peirson* 4707 (F.P.); Near Glen Ivy, *Howell* 1044 (S.A.); Roadside, Mt. San Jacinto, *Spencer* 1191 (C.A.); Slope of Mt. San Jacinto, *Spencer* in 1919 (P).

4. GILIA PLURIFLORA Heller, Muhl. **2**: 113. 1906. *Gilia virgata* var. *floribunda* A. Gray, Proc. Am. Acad., **8**: 272. 1870 (Not *Gilia floribunda* Gray). *Navarretia virgata* var. *floribunda* (Gray) Brand, Pflanzenreich IV, **250**: 168. 1907; *Gilia Brauntonii*, J. & M., Jepson, Ec. Pls. Calif., 130. 1924; *Hugelia Brauntonii* (J. & M.) Jepson, Man. Fl. Pls. Calif., 793. 1925.

Plant annual, 12–35 cm. high; stem rarely simple, commonly corymbose branched; leaves sessile 15–50 mm. long, pinnately parted into 3–7 filiform divisions; flower clusters densely floccose; large, 15–40 mm. broad, 8–50-flowered; corolla well exserted, vivid blue to violet, salverform, 13–18 mm. long, lobes two thirds as long as tube; stamens 4 mm. long, attached at sinuses, exserted.

Type locality, Sunset, Kern Co., Calif. Range, this species is found in the hot interior valleys of Calif. from Alameda Co. to southern Kern Co. In Tulare and Kern Counties the species reaches its maximum development in size of heads and in length of the filiform leaves. Representative material studied, CALIFORNIA: Alameda Co., Corral Hollow, Geologic Survey Calif. no. 1212 *Brewer* (C). Monterey Co., Coburn Mill, *T. S. Brandegee* in 1879 (C). Mariposa Co., Yosemite, *Dodd* in 1891 (C). Fresno Co., Coalinga, *Condit* in 1910 (C). Tulare Co., Badger, *Brandegee* in 1892 (C); Middle Tule River, *Dudley* 876; Lemon Cove, *Condit* May 20 (P); South Fork of Kaweah River, *Culbertson* in 1904 (P, C); Kaweah River Valley, *Coville* and *Funston* 1318 (S); above Coffee Pot Canyon, El. 9000 ft. Sequoia National Forest, *Dudley* 1784 (S). San Luis Obispo Co., Estrella, *Jared* in 1897 (C). Kern Co., Bakersfield, *Davy* 1730 (C); north slope Tehachapi, *Munz* 11,428 (P); Sunset, *Heller* 7734 (C, S); Cameron, *Brandegee* in 1884 (C); Fort Tejon, *Parish* 1897 (S). Santa Barbara Co., 55 mi. east of Santa Maria, *Munz* 11,416 (P, C).

The following specimens approach *G. virgata*. Monterey Co., Cholame Valley, *Lemmon* in 1878 (C); *Congdon* in 1893 (P, C). Los Angeles Co., road from Palmdale to Victorville, *Peirson* 923 (F.P.).

Although the species has frequently been considered as merely a variety of *G. virgata*, it should, I believe, be considered distinct because the species are so strikingly different, and evidences of intergradation are not great for entities within such a variable group.

5. **Gilia Sherman-Hoytae** Craig n. sp.

Erect annual 6–12 cm. high, much branched; stems slender, dark red brown; flower clusters 7–20, with 2–8 flowers to a cluster; corolla well exserted, 14½–17 mm. long, commonly regular or very rarely but slightly irregular with the dominant color a pale but vivid coerulean blue, very rarely white or pale lavender; lobes 5 mm. long, more than half as broad, pale, vivid coerulean blue, or very rarely with one or two light pencilings at base; tube 12 mm. long, at least twice as long as lobes, the upper third orange yellow, the lower third purple; stamens 4 mm. or less in length, attached at or near sinuses; anthers 1–1½ mm. long. (Annua, erecta, 6–12 cm. alta, ramosa; caulibus tenuibus; capitulis 4–20, cum 2–8 floris; corollis exsertis, 17 mm. longis, regularibus, coeruleis; lobis corollarum 5 mm. longis, ca. 3 mm. latis; tubo 12 mm. longo; staminibus 3–4 mm. longis; antheris 1–1½ mm. longis.)

Type, Sandy Flats 10 mi. south of Muroc, Los Angeles County, California, *Munz* and *Craig* 12,925, Pomona College Herbarium no. 185,022. Isotypes widely distributed. Range, all the collections of this species I have seen are from the Antelope Valley, in Los Angeles and Kern Counties, Calif. Representative material studied, CALIFORNIA: 12 mi. south of Muroc, *Munz* and *Craig* 12,930 (P), *Peirson* 7268 (P, F.P.); between Redman and Muroc, *Hoffmann* in 1931 (C.A.), *Hoffmann* (S.B.); Muroc, *Hoffmann* (S.B.); Lancaster, *Davy* 2278 (C), *K. Brandegee* in 1909 and 1910 (C); 16 mi. east of Lancaster, *Munz* and *Craig* 12,952 (P).

This species is very local, for the only place it is known to grow is in the Antelope Valley region near Lancaster and Muroc, where in favorable seasons it abounds in the low sandy flats and sand dune areas forming large masses of vivid coerulean blue. One collection, Maricopa Hills, Kern Co., *Eastwood* 3272 (C.A.), which I believe, represents an intermediate form between *Sherman-Hoytae* and *pluriflora* is the only collection possibly referable to this species which I have seen that does not come from within a radius of 20 miles from the type locality.

Superficially this plant resembles *G. eremica*, but the flowers are regular, the stamens short and attached near the sinuses, the anthers are very small and similar to those of *G. filifolia*, the corolla lobes are short as in *G. filifolia* but the flower averages more than twice as long as *G. filifolia* and is

correspondingly large, being well exserted, in this respect resembling *G. pluriflora*. Because of these characters, it is difficult to state to which of these species it is most closely related, but the general flower structure, especially the stamens and anthers, would indicate a close relationship to *G. filifolia*, in spite of the fact that superficially it resembles more closely either of the other species. This species is named in honor of Mrs. Albert Sherman Hoyt, who has contributed much to the Botany of the Southwest through her work to preserve the flora of the deserts.

6. **Gilia eremica** (Jepson) n. comb. *Hugelia eremica* Jepson, Man. Fl. Pls. Calif., 793. 1925; *Gilia floccosa* Gray, Proc. Am. Acad. **8**: 272. 1870, in part, not as to type. *Hugelia floccosa*, Nutt., ex. Gray, l.c. *Gilia virgata* var. *floccosa* (Gray) Milliken, Univ. Calif. Pub. Bot. **2**: 40. 1904, in part; *Navarretia virgata* subsp. *floccosa* Brand, Pflanzenreich IV, **250**: 168. 1904, in part; *Welwitschia floccosa* Rydb., Fl. Rocky Mts., 688, 1065. 1917, in part.

Plant annual, 3–25 cm. high, floccose, glabrate in age, rarely somewhat glandular or sub-glabrous; stem commonly much branched from base or rarely almost simple; leaves 8–45 mm. long; flower clusters 2–more than 100, lanate, 2–10-flowered; bracts 3–7-lobed; flowers well exserted, commonly strongly two lipped, or rarely almost regular, white, lavender, or blue, variously marked; from 2–8½ mm. long; attached at sinuses or in the tube; anthers from less than 1 to 2 mm. long.

This use of the name *G. eremica* is much more inclusive than that of Jepson, and there are several good reasons for this usage. *G. eremica* var. *typica* is much more common and widespread than hitherto recognized. The species is a highly variable one and runs into a number of forms with corollas of variable irregularity. These varieties again show indications of intergradation with other species. These intergradations have been discussed under *G. Sherman-Hoytae*, *G. virgata* vars. *sapphirina* and *ambigua* and will be discussed under *G. filifolia* var. *diffusa*. Most of these have been referred to *G. floccosa* a name which must be placed in synonymy because of its original use by Gray as a new name for *G. lutescens* Steud. (*G. lutea* Benth.). This name, *floccosa*, has been applied to many forms of at least two or three species. Because of the uncertainty of this later usage it is obviously desirable to drop the name in accordance with accepted rules of nomenclature.

KEY TO VARIETIES

A. Leaves with from 5–9 linear lobes, flowers markedly irregular. Deserts of So. Calif. and southwest Nevada.

6a. *Gilia eremica* var. *typica*.

AA. Leaves commonly linear or 3-lobed, rarely 5-lobed, Arizona, Utah, Nevada.

B. Corolla 14 mm. long or longer; stamens 3–8½ mm. long, the anthers more than 1 mm.

C. Corolla markedly irregular; the lobes two thirds the length of tube, more than 2 times as long as broad; longest stamen more than 3 times longer than shortest stamen; never glandular. High elevations, Utah, So. Nevada, Northern Arizona.

6b. *G. eremica* var. *zionis.*

CC. Corolla slightly irregular; the lobes about ½ length of tube, the lobes less than 2 times as long as broad; longest stamen about 2 times longer than shortest stamen. Sometimes glandular.

6c. *G. eremica* var. *arizonica.*

BB. Corolla less than 13 mm. long, very slightly irregular; the stamens 2–3 mm. long, the anthers less than 1 mm. long. Southern Arizona.

6d. *G. eremica* var. *Yageri.*

6a. **Gilia eremica** (Jepson) var. **typica** n. nom. *Hugelia eremica* Jepson, Man. Fl. Pls. Calif. 793. 1925; *Navarretia densifolia* var. *jacumbana* Brand, Ann. Conserv. et Jard. Bot. Genève, **15 & 16**: 340. 1913.

Plant commonly floccose, or rarely glabrate, or sub-glabrous, much branched from base 8–20 cm. high; leaves usually recurved, 1–4 cm. long, oblong in outline with from 5–9 linear lobes; the lobes 2–8 mm. long; flower clusters 5–more than 100, lanate, 3–10-flowered; bracts 3–7-lobed; flowers well exserted, bilabiate rarely white, more commonly pale lavender, unmarked, or with the upper 3 lobes with red violet markings at base, the lower 2 lobes pale lavender and unmarked; corolla 16 mm. long; lobes 6 mm. long; tube 10 mm. long, variably marked with yellow and lavender; stamens attached about 1 mm. below sinuses and of variable length from 2–6 mm. in length, a common arrangement being 2 excumbent and short, and 3 incumbent and long, or 1 short, 2 medium and 2 long, always with at least one stamen well exserted; anthers 1½–2 mm. long.

Type locality, Calico Wash northeast of Barstow, Mohave Desert, California. Representative material studied, CALIFORNIA: Colorado Desert, San Bernardino Co., Morongo Pass, *Armacost* in 1928 (P); Morongo Valley, *J. T. Howell* 536 (S.A.). Colorado Desert, Riverside Co., Morongo Wash, *Gilman*, a15 (P); Whitewater, *Jones* in 1926 (P), *Munz* 4552 (P); Coachella Valley, *Gilman* in 1928 (P); Palm Springs, *Munz* and *Harwood* 3526 (C, P), *Jones* in 1903 (P); Van Deventer's, *Hall* and *Jepson*, 1892. Colorado Desert, San Diego Co., Borego Valley, *Munz* and *Hitchcock* 11,336 (P); Sentenac Canyon, *Munz* and *Hitchcock* 11,365 (P); Palm Creek, *T. S. Brandegee* in 1895 (C). Mohave Desert, San Bernardino Co., 2½ mi.

east of Barstow, *Wolf* 3390 (S.A.); Calico Wash N.E. of Barstow, *Jepson* 5414 (Herb. Jeps. Type); Daggett, *Hall* 6142 (C); Barstow, *K. Brandegee* in 1909 (P); Helendale, *Craig* 1390 (P); Kramer, *K. Brandegee* in 1912 (P); 3 mi. east of Deadman's Point, *Munz* 12,950 (P); Box S Ranch, *Munz* and *Hitchcock* 12,172 (P, C), *Jones* in 1926 (P); Adelanto, *S. B. Parish* 11,806 (C); Cave Spring, Old Dad Mt., *Jones* in 1926 (P); Providence Mts., *Munz, Johnston* and *Harwood* 4280 (P); Old Woman Mts., *Jones* in 1926 (P); Fenner, *Munz, Johnston* and *Harwood* 4175 (P). Mohave Desert, Kern Co., Indian Wells Valley, *F. Peirson* in 1927 (F.P.); Bissell, *K. Brandegee* in 1912 (P); Mohave, *Jones* in 1884 (P), *Jones* in 1903 (P); Walkers Pass, *Purpus* 5391 (C); Argus Mts., *Purpus* 5421 (C). NEVADA: Canyon Station, Clark Co., *Heller* 10,435 (C).

G. eremica var. *typica* is a very common plant in the southern Mohave Desert and on the northern Colorado Desert. In this area, the center of its range, it is a very distinct and stable form, but along the borders of its range it intergrades freely with other forms.

The following collections from along the eastern slopes of San Jacinto and other principal dividing ranges to the southward seem to show a definite tendency toward smaller, darker, more regular flowers. They remotely approach the irregular flowered frorms of *virgata*. San Bernardino Co., Banning, *Gilman* 21 (C). San Diego Co., San Felipe Valley, *Keck & McCully*, 66 (P), *K. Brandegee* in 1899 (P); Desert slopes, Jacumba, *Abrams* 3640 (P, C). This is the type collection of *G. densifolia* var. *jacumbana* Brand; San Jacinto Mt., 5000 ft., *Spencer* 1018; eastern base of San Jacinto Mts., *Hall* 2119 (C).

To the east var. *typica* seems to intergrade with var. *zionis*. ARIZONA: Ft. Mohave, *Lemmon* in 1884 (C). NEVADA: Las Vegas, *Craig* 1462 (P); Bunkerville, *Jones* in 1923 (P). CALIFORNIA: Cima, *K. Brandegee* in 1915 (C). *G. eremica* var. *typica* is a plant of the lower altitudes while var. *zionis* is from higher altitudes.

6b. **Gilia eremica** var. **zionis** Craig n. var.

Plant 6–25 mm. high; leaves 8–30 mm. long, linear or 3-lobed, rarely 5-lobed; the lobes arising from the basal third of rachis; corolla irregular but less so than in *typica*, 14 mm. long; the lobes 6½ mm. long less than ½ as wide, commonly blue or tinged with lavender; tube 8 mm. long, variously marked; stamens attached in tube about 2 mm. below sinuses of variable length, a common arrangement being one 2 mm. long, two 7 mm. long, and two 8½ mm. long. (Planta 6–25 mm. alta; foliis 8–30 mm. longis, linearibus vel 3-lobatis, lobis corollarum 6½ mm. longis, 2½–3 mm. latis, azureis, tubo 8 mm. longo; staminibus in tubo adnatis, ca. 2 mm. infra sinos.)

Type, Zion National Park, Utah, June 18, 1928, *Craig* no. 1400, Pomona College Herbarium no. 184,135, isotype Pomona College Herbarium no. 182,268. Representative material studied, UTAH: Zion National Park, *Craig* 1402 (P), *Craig* 1418 (P); Beaver Dam Mts., *Craig* 1394 (P); between St. George and Las Vegas, *Goodman* and *C. L. Hitchcock* 1665 (C); La Verken, *Jones* 5194 (C, P), *Jones* 5189 (P). ARIZONA: Burnt Canyon, Coconino Co., *Cottom* 4198 (P); Agua Caliente, *Carlson* in 1914 (C.A.); road from Chloride to River, *Eastwood* 15,326 (C.A.); Oatman, *Eastwood* 18,206 (C.A.); Kingman, *Eastwood* 18,026 (C.A.). NEVADA: base of Charleston Mts., *Tidestrom* 9659 (C.A.).

The following collections are intergrades very near to var. *zionis*, but approaching vars. *typica* and *arizonica*. UTAH: La Sal Mts., *Purpus* in 1899 (C). ARIZONA: Clifton, *Rusby* 269 (C); Yucca, *Jones* 9936 (P). CALIFORNIA: Panamint Valley, Inyo Co., *Parish* 10,162 (C); Barnwell, *Brandegee* in 1911 (C); Darwin Mesa, *Hoffmann* (S.B.).

Var. *zionis* is the variety of *G. eremica* most closely related to var. *typica;* however, there seems to be very little intergradation between these two forms. The main differences between var. *typica* and var. *zionis* are that *zionis* is bluer and darker colored, it has a slightly less irregular corolla, the leaves are much less lobed, frequently being entire, when lobed, the lobes arise from the basal one third of the rachis.

6c. **Gilia eremica** var. **arizonica** Craig n. var.

Plant 4–20 mm. high, much branched; stems floccose-lanate or rarely glandular; leaves 10–45 mm. long, linear to 5-lobed, the lobes mostly basal; flower clusters loosely lanate; corolla 14–17 mm. long slightly irregular; lobes 5–6 mm. long, ½–⅔ as wide, blue; tube variously marked, the dominant color yellow; stamens attached about 2 mm. below sinuses, 3–6 mm. long. (Planta 4–20 mm. alta, multoramosa; caulibus floccoso-lanatis, rariter glandulosis; foliis 10–45 mm. longis, parce irregularibus, lobis 5–6 mm. longis, 2½–4 mm. latis, azureis; tubo luteo; staminibus 3–6 mm. longis.)

Type, Wickenburg, May 5, 1903, alt. 2100 ft., Jones 10,253, Pomona College Herbarium no. 74,569. Representative material studied, ARIZONA: Apache Trail, *Nelson* 6303 (C); Prescott, Phoenix highway, *Nelson* 10,263 (C); Roosevelt Dam, *Eastwood* 8686 (C.A.); Mazatzal Mts., *Eastwood* 16,937 (C.A.); Peach Springs, *Wilson* 145 (C); Franconia, *Jones* 1903 (P).

The following collections are small flowered forms representing intergrades with vars. *zionis* and *Yageri*. ARIZONA: Skull Valley, *Jones* 10,250 (P); Hillside, *Jones* 10,279 (P); Sierra Ancha, *Eastwood* 16,962 (C.A.); Globe, *Eastwood* 8654 (C.A.); Pinal Mt. on road to Winkleman, *Eastwood*, 17,318 (C.A.); Hualpi Indian Reservation, *Dudley* in 1931 (C.A.); Verde, *Wyatt Jones* in 1920 (C).

Var. *arizonica* is a large flowered form of *G. eremica* with a less irregular corolla and with short broad corolla lobes. It is found in the Lower Sonoran life zone in Arizona, most commonly in the southern part of the state. The collection by Mr. Jones, Wickenburg in 1903, which I have cited as the type, is marked by Mr. Jones as *Gilia virgata* var. *ambigua* type. Later he published this name for a different form from California and then cited this sheet as typical of var. *Yageri*. When selecting a type for var. *Yageri* from the long list of collections cited by him as typical, I have, on the advice of Dr. Munz, taken the collection from Yager's as the type sheet. Because this specimen from Wickenburg is most typical of var. *arizonica*, I am naming it the type of that variety. Nelson 10,303 and 10,263 are also extreme examples of the variety.

6d. **Gilia eremica** var. **Yageri** (Jones) n. comb. *G. virgata* var. *Yageri* Jones, Cont. W. Bot. **13**: 2. 1910.

Plants 3–15 mm. high, lanate to sub-glabrous; leaves 7–20 mm. long, linear to 5-lobed which lobes arise from basal third of rachis; flower clusters 2–25, 2–5-flowered; corolla slightly irregular, 12 mm. long, lobes 5 mm. long, half as wide, pale blue; tube yellow; stamens 2–3 mm. long attached near sinuses; anthers 1 mm. long or less.

Type locality, Yager's north of Tucson, Arizona. Representative material studied, ARIZONA: Sacaton Mts., Pinal Co., *Peebles* and *Harrison* 1069 (P); Sacaton, *Peebles* 6515 (C.A.), *Eastwood* 8021 (C.A.); forty miles north of Tucson, *Jones* 25,672 (P); foot of Baboquivari Mts. 15 mi. northeast of Sells, *Fosberg* 7786 (P).

The following sheets are somewhat atypical but are more closely related to var. *Yageri* than to *G. filifolia* var. *diffusa*, the form to which they are most closely related. ARIZONA: mesa near Tucson, *Pringle* in 1883 (P); Tucson, *Eastwood* 8066 (C.A.), *Toumey* in 1894 (C); west side of Santa Catalina Mts., near Tucson, *Lemmon* 241 (C); Pinal Mt., *Eastwood* 17,318 (C); Hackberry, *Jones* 10,267 (P); *Jones* 10,269 (P); Wickenburg, *Jones* 10,265 (P); Phoenix, *Jones* 10,266 (P). MEXICO: 15 miles north of Magdalena, Sonora, *Fosberg* 7787 (P).

Var. *Yageri* is a very confusing form and I am uncertain to which species it should properly be referred, the flower is more regular than in any of the other varieties of *G. eremica* and the stamens are attached much closer to the sinuses and are short and with small anthers. These stamen characters indicate a relationship to *G. filifolia*, and in habit the plant closely approximates var. *diffusa* of that species, to which it is obviously very closely related. It is no doubt more closely related to both var.

diffusa and the Arizona varieties of *G. eremica* than to *G. virgata* the species to which it was originally referred.

In his description of var. *Yageri*, M. E. Jones referred to the variety a number of sheets from Arizona, Nevada, Utah, and California. The specimen first cited was his no. 10,250 from Skull Valley, Arizona which I here refer to var. *arizonica*. He himself wrote "I regard the types as Nos. 10,279 and 10,253," the former being from Hillside, Arizona and so imperfect a specimen as to be impossible of exact reference, while the latter I am using as the type of var. *arizonica*. In view of the fact that Mr. Jones cites also Utah material referrable to var. *zionis*, and a California plant belonging to *G. eremica* var. *typica* it is evident that he incuded under his var. *Yageri* plants of four different entities. Since his use of the word "type" is not that of a single specimen, and since he used the name *Yageri* and cited a specimen from Yager's, it would seem to give the least confusion to retypify var. *Yageri* and to designate as the type the plant from which he drew the name, i.e. *Jones* 9935, from Yager's, north of Tucson, Arizona, Pomona College Herbarium no. 74,576.

7. **Gilia filifolia** Nutt., Journ. Acad. Phil. n. s. 1:56. 1848. *Gilia virgata* var. *filifolia* (Nutt.) Milliken, Univ. Calif. Pub. Bot. **2:** 39. 1904; *Navarretia filifolia* (Nutt.) Brand, Pflanzenreich IV, **250:** 167. 1907; *Navarretia filifolia* subsp. *eufilifolia* Brand, l.c.; *Eriastrum filifolium* (Nutt.) Wooton and Standley, Contrib. U. S. Nat. Herb. **16:** 160. 1913; *Gilia floccosa* var. *filifolia* (Nutt.) Nels and Macbride, Bot. Gaz. **61:** 35. 1916; *Welwitschia filifolia* Rydb., Fl. Rocky Mts. 688. 1065. 1917: *Hugelia filifolia* Jeps., Man. Fl. Pls. Calif. 792. 1925.

Plant annual; canescent-lanate to sub-glabrous; 3–30 cm. high; flowers 7–9 mm. long, blue to almost white or rarely yellowish or pinkish; lobes about half the length of the tube or less; stamens 1–2½ mm. long, not well exserted; the anthers cordate oval ½–1 mm. long.

Like *G. virgata* and *G. eremica*, *G. filifolia* is a species with a wide distribution and with numerous geographic races. The species is found from California to Texas, and from Lower California to Washington and Idaho. It is a complex group with considerable intergradation between the varieties and to some extent with other species. The smallness of the flowers adds to the difficulty of studying the group. Besides flower size the best taxonomic characters are the relative shortness of the corolla lobes, the shortness of the stamens, and the small size of the anthers. However *Wilcoxii* has all these latter structural characters, and *G. Sherman-Hoytae* has relatively short lobes and stamens, but the anthers, though small (1–1½ mm.), are not as small as those of *G. filifolia* (1 mm. or less). *G. eremica* var.

Yageri, as mentioned in the discussion of that variety, has small anthers and resembles *G. filifolia* var. *diffusa* in respect to habit.

KEY TO VARIETIES

A. Lobes of the bracts often exceeding 5 mm. in length; corolla limb blue; plant pilose to sub-glabrous. Plants of cismontane Calif. from Santa Barbara into Lower California.

7a. *Gilia filifolia* var. *typica*.

AA. Lobes of the bracts rarely 4 mm., never exceeding 5 mm. long; corolla limb pale to almost white, or yellowish, or pinkish. Floccose becoming glabrate. Plants mainly of desert areas of the northwest, or very rarely in Mts. of southwest.

B. Corolla lobes apiculate. Plants of the sand hills of eastern Riverside County and San Bernardino County.

7c. *G. filifolia* var. *Harwoodii*.

BB. Corolla lobes not apiculate.

C. Stems erect from base.

7d. *G. filifolia* var. *sparsiflora*.

CC. Stems decumbent from base. Plants of the southwest deserts.

7b. *G. filifolia* var. *diffusa*.

7a. **Gilia filifolia** Nutt. var. **typica** n. nom. *Gilia filifolia* Nutt., l.c.

Plant pilose to sub-glabrous, 4–40 cm. high; stem simple and virgate or many branched from base or axils; leaves 3–35 mm. long, slender filiform or with two filiform lobes at base; flower clusters 3–15-flowered; larger bracts 12–20 mm. long, lanate; flowers 9 mm. long; lobes 3 mm. long 1 mm. wide, blue; tube twice length of lobes, yellow; stamens 2½ mm. long attached to tube 1 mm. below sinuses; anthers cordate, oval, ½ mm. long.

Type locality, said to be Santa Barbara, California. Representative material studied, CALIFORNIA: Santa Barbara Co., Blochman's Ranch, near Santa Maria, *Eastwood* 453 (C.A.). San Diego Co., 18 mi. north of Lakeside, *Craig* and *Zornes* 1856 (P); La Jolla, *Clements* 81 (C); Granite, Vicinity of San Diego, *Spencer* 66 (C); Potrero, *Abrams* 3724 (P); San Diego, *Brandegee* in 1906 (C); Cuyamaca, *T. S. Brandegee* in 1894 (C); between Escondido and Bonsall, *Craig* and *Zornes* 1857 (P).

The following specimens differ from the specimens from California in habit, being more branched and somewhat dwarfed. The flower structure is like *typica* and I feel they should be referred here. LOWER CALIFORNIA: Ryerson's Ranch, *Brandegee* in 1893 (C); Lower Calif., *Bran-*

degee in 1893 (C); Tia Juana, *Orcutt* in 1883 (C); San Telmo, *T. S. Brandegee* in 1893 (C); Ensenada, *Jones* in 1925 (P).

The following specimens closely approach var. *diffusa;* Llano de Santana, *T. S. Brandegee* in 1889 (C); San Julio, *T. S. Brandegee* in 1889 (C).

The following collections represent intergrades: Elizabeth Lake Canyon, *Hoffmann* (S.B.) represents a large flowered intergrade with *virgata;* Frazer Mt. Park, So. Kern Co., *Hoffman* (S.B.) represents an intergrade with *sparsiflora* or *Wilcoxii.*

G. filifolia var. *typica* is the coastal race of *G. filifolia* and is found from Southern California south into Lower California, being most common in San Diego Co. There are two quite distinct races within the variety, those from the northern part of the range being erect and virgate in habit, and appearing very much like a small flowered *G. virgata* var. *typica.* In Lower California the plant is decumbent from the base and diffusely branched. Because there is very much intergradation between these two races and because they are identical in flower structure, I have deemed it wise to group them under one name. Together they form a rather distinct group which intergrades with the other varieties through the Lower California plants. Although there are other characters, such as a tendency towards glabrousness, and relative darkness of flower color, the long filiform lobed bracts around the flower-clusters is the more constant and is the most obvious character.

It is through *G. filifolia* var. *typica* that the sub-genus *Hugelia* approaches *Navarretia,* for *Navarretia Abramsii* is not only superficially like *G. filifolia* but differs from it but slightly in flower structure having oval instead of sagittate anthers. It must be noted that *G. filifolia* var. *diffusa* frequently has oval anthers.

7b. GILIA FILIFOLIA var. DIFFUSA Gray, Proc. Am. Acad. **8**: 272. 1870. *Navarretia filifolia* var. *diffusa* Brand, Pflanzenreich IV, **250**: 167. 1907; *Welwitschia diffusa* Rydb., Fl. Rocky Mts., 688, 1065. 1917, in part. Probably *Hugelia virgata* var. *pygmaea* Jepson., Man. Fl. Pls. Calif., 793. 1925.

Stems decumbent from base diffusely branched, 3–15 cm. high, thinly pilose, glabrate in age; leaves 3–15 mm. long, simple, linear or divided into 3–5 linear lobes; flower clusters 5–more than 100, 3–20-flowered; longest bracts rarely 12 mm. long, commonly 8 mm., the lobes of the bracts linear, not filiform; calyx 4–5 mm. long lanate; flowers 7–8 mm. long, pale blue to white; corolla lobes 2½ mm. long; tube 8 mm. long; stamens 2–2½ mm. long; anthers about ½ mm. long, cordate, oval.

Type locality, "Fort Mohave and Nevada to New Mexico and the borders of Texas." Representative material studied, CALIFORNIA: San Diego Co., San Felipe Hill, *Jones* in 1906 (P); *K. Brandegee* in 1899 (C).

Riverside Co., Morongo Wash, *Munz* 11,921 (P); Palm Canyon, *Wilder* 709 (P); Colorado Desert, *Hall* 5965 (C); Borego Spring, *Jones* in 1906 (P); Yaqui Well, *Eastwood* 2680 (C.A.). San Bernardino Co., Morongo Wash, *Munz* and *Johnston* 5169 (P, C); Cima, *K. Brandegee* in 1915 (P, C); Providence Mts., *T. S. Brandegee* in 1902 (C); Needles, *Jones* in 1884 (P, C); Hackberry Mt., *Wolf* 3265 (S.A.). Kern Co., Lancaster, *Hoffmann* in 1930 (C.A.), *K. Brandegee* in 1909 (C). NEVADA: Fort Mohave, *Lemmon* in 1884 (C). ARIZONA: Tucson Plains, *Lemmon* 170 and 173 (C); Tucson to Nogales, *Peebles* and *Harrison* 7039 (C.A.); Kingman, *Eastwood* 18,385 (C.A.); Peach Springs, *Wilson* 146 (C); Nogales, *T. S. Brandegee* in 1892 (C); Congress Junction, *Jones* in 1903 (P); Sonoita, *Harrison* 7183 (P); Yucca, *Jones* in 1884 (P). Pima Co., Continental, *Harrison* 6941 (P). Maricopa Co., Wittman, *Peebles, Kerney* and *Hastings* 6799 (P); Douglas, *Carlson* in 1915 (C.A.). NEW MEXICO: Silver City, *Eastwood* (C.A.); Bowie, *Eastwood* (C.A.); Organ Mts., *Wooton* in 1900 (P, C.); Lordsburg, *Jones* 25,671 (P). UTAH: Milford, *Jones* in 1880 (P, C). TEXAS: El Paso, *Jones* in 1884 (P); Fort Bliss, (C.A.); Fort Bliss, *Clemens*, in 1917 (P).

G. filifolia var. *diffusa* has a wide distribution, being found from Calif. to Texas. It is a difficult variety to understand for it varies greatly and apparently merges with *G. eremica* through var. *Yageri* of that species. In this area the two forms are identical in habit, but can be distinguished by a careful examination of the flowers. Var. *diffusa* has smaller flowers, commonly 8 or less mm. long while in var. *Yageri* they are commonly 10–13 or more mm. in length, never less than 9 mm. In var. *diffusa* the stamens are short and not exserted while in var. *Yageri* they are exserted. The anthers of var. *diffusa* are relatively broader. Northward var. *diffusa* shows indications of intergradation with var. *sparsiflora*. Collections from the far eastern part of its range, from Texas, New Mexico, and Utah, have the anthers almost round. One sheet, Mrs. Joseph Clemens' collection from Fort Bliss, Texas may represent a local race closely related to var. *diffusa*. Superficially the plant resembles desert collections of var. *sparsiflora*. In the deserts of Southern California var. *diffusa* is more readily identified; the source of confusion here is with var. *Harwoodii*, as discussed under that variety.

7c. **Gilia filifolia** var. **Harwoodii** n. var.

Plant erect, canescent-lanate, glabrate in age; leaves 5–25 mm. long; longest bracts 10–15 mm. long; corolla 7½ mm. long; corolla lobes 2¾ mm. long, apiculate; stamens 1–1½ mm. long attached nearer the sinuses than in *diffusa*. (Planta erecta, canescenti-lanata, tarde glabrata; foliis 5–25 mm.

longis; bracteis longissimis 10–15 mm. longis; corollis 7½ mm. longis; lobis 2¾ mm. longis, apiculatis; staminibus 1–1½ mm. longis.)

Type, sandy desert 1200 ft., Blythe Junction, Riverside Co., California, *Munz* and *Harwood* 3589, April 2, 1920, Pomona College Herbarium no. 7622. Representative material studied, CALIFORNIA: Riverside Co., south of Rice, *Wolf* 3119 (S.A.). San Bernardino Co., Kelso, *Jones* in 1906 (P), *Brandegee* in 1915 (P, C).

Var. *Harwoodii* is a variety from the sand hills near Blythe and near Kelso, Calif. It is closely related to var. *diffusa* but differs in being more erect, more woolly, and in having the corolla lobes apiculate.

7d. **Gilia filifolia** var. **sparsiflora** (Eastwood) Macbride, Cont. Gray Herb. n.s. **49**: 58. 1917. *Gilia sparsiflora* Eastwood Cal. Acad. Science, Series 3, vol. **2**: 291. 1902; *Navarretia filifolia* subsp. *sparsiflora* Brand, Pflanzenreich IV, **250**: 167. 1907; *Hugelia filifolia* var. *sparsiflora* Jepson, Man. Fl. Pls. Calif., 792. 1925.

Plant floccose, sometimes glabrate, erectly branching 10–30 cm. high; flower clusters 2–5-flowered; leaves linear or with a pair of short lobes at base; lobes at base of bracts pungent, rarely more than 4 mm. long; calyx 5–6 mm. long, corolla pale blue, almost white, or rarely pinkish 7–8½ mm. long, corolla lobes 3 mm. long; stamens sagittate, linear to oblong.

Type locality, King's River Canyon, California. Representative material studied, OREGON: Gateway, Jefferson Co., *Abrams* 9594 (P); Bend, Crook Co., *E. Nelson* 861 (C, U. of Wyo.); Anderson Valley, *Leiberg* 2385 (C); Desert Well near Button Springs, *Leiberg* 387 (C, P): Burnes, Harney Co., *Henderson* 8930 (C.A.); Base of Steins Mt., *T. Howell* 1885 (S). CALIFORNIA: El Dorado Co., Fallen Leaf Lake near Tahoe, *Eastwood* 7859; Lakeside Park, *Geis* 107 (C). Lake Co., Glenbrook, *Jusset* in 1928 (C.A.). Sierra Co., Loyalton, *Eastwood* 7859 (C.A.). Lassen Co., Eagle Lake, *M. S. Baker* and *Nutting* in 1894 (C); South side Rixey Mts., *M. S. Baker* and *Nutting* in 1894 (C). Kern Co., Near Isabella, *Hoffmann* (S.B.). Mono Co., Coville, *Jones* in 1929 (P). Fresno Co., South Fork of King's River, *Eastwood* in 1899 (C.A.) Cited as typical material by Miss Eastwood. Ventura Co., Frazer Borax Mine, *Abrams* and *McGregor* 199 (S); Lockwood Valley, *Hoffmann* 1552 (S.B.), *Dudley* and *Lamb*, 4685 (S); Mt. Pinos, *Hall* 6580 (C), *Hoffmann* (S.B.). San Bernardino Co., Morongo King Mine, *Parish* 3329 (S); Cactus Flats, *Munz* 10,500 (P, C). LOWER CALIFORNIA: Valley of Palms, *Jones* 9911 (P). NEVADA: Ormsby Co., Eagle Valley, *Baker* 1403 (C, P), *Baker* 11,435 (P); Carson City, *Jones* in 1897 (P), *Jones* 9910 (P) in part; Empire City, *Jones* 3968 (P); *Jones* 3969 (P) in part, Washoe Co., Franktown, *Jones* in 1882 (P); Washoe,

Heller 10,603a (C); Reno, *Hillman* in 1893 (C), *Munz* 11,101 (P); Franktown, *K. Brandegee* in 1911 (C); Verdi, *K. Brandegee* in 1911 (C). Humboldt Co., Big Creek Ranch, *Taylor* and *Richardson* 49 (P). White Pine Co. Shellborne, *Jones* in 1891 (P). IDAHO: Picaba, Blaine Co., *Macbride* and *Payson* 2984 (C).

Var. *sparsiflora* was originally described by Miss Eastwood from specimens collected in the Sierra Nevada. These represent a rare race of the variety, for there are two poorly defined races. The first from montane and cismontane California of which Miss Eastwood's collections are typical; as is *Hall* 6580 from Mt. Pinos (P). The other race is from desert regions of California, Oregon, Washington, Nevada and Idaho, and is more woolly and has larger flower clusters; *Munz* 11,101 is typical of this race.

Var. *sparsiflora* is very close to *G. Wilcoxii* and intergrades with that species. As examples of this intergradation I list the following collections, CALIFORNIA: Boca, Nevada Co., *Sonne* in 1888 (C). WASHINGTON: Crab and Wilson Creeks, Douglas Co., *Sandberg* and *Leiberg* 246 (C); Washington territory, *Canby* 1883 (C). OREGON: Devine Ranch, *Leiberg*, 2408 (C). IDAHO: Nampa, Canyon Co., *Macbride* 1069 (C); King Hill, Elmore Co., *Nelson* and *Macbride* 1093 (C); Challis, Custer Co., *Macbride* and Payson (C). As possible intergrades with var. *typica*, I cite the following, CALIFORNIA: Humboldt Co., Hyampun River, *Chestnut* and *Drew* in 1888 (C). Lake Co., *K. Brandegee* (C.A., S).

8. Gilia Wilcoxii A. Nels. Bot. Gaz. **34**: 27. 1902. *Navarretia Wilcoxii* (A. Nels.) Brand, Pflanzenreich IV, **205**: 165. 1907; *Welwitschia Wilcoxii* (A. Nels.) Rydb., Fl. Rocky Mts., 688, 1065. 1917, as to name. *Gilia floccosa* Gray, Proc. Am. Acad. **8**: 272. 187 in part, not as to type.

Plant floccose, erectly branching, 8–25 mm. high; leaves commonly 5-lobed rarely 3-lobed, never entire; flower clusters blue to pale blue or rarely pinkish; 10–13 mm. long; lobes 4–5 mm. long; stamens commonly about 2 mm. long commonly inserted about 1 mm. below sinuses, anthers ¾—1 mm. long.

Type locality, near St. Anthony, Idaho. Representative material studied, UTAH: Gold Hill, Deep Creek Mts., *Jones* in 1891 (P); Dutch Mt., Tooele Co., *Jones* 9915 (P), *Jones* in 1891 (P). CALIFORNIA: Kern Co., Between Coso Hot Springs and Coso Junction, *Ferris* 7450 (S). Inyo Co., Lone Pine, *Jones* 9932 (P); Chat, *Hillman* in 1897 (P); Wyando Creek near Deep Springs Valley, *Ferris* 1374 (S); Taboose Pass, *Peirson* in 1913 (F.P.); Hockett Trail, *Peirson* in 1911 (F.P.); Panamint Mts., *Coville* and *Funston* 2143 (S); Surprise Canyon near Panamint City, *Howell* 3897 (C.A.); Castle Peak 9000 ft., *Diel* 39 (P); Bishop Creek, *Jones* in 1926 (P); Black Canyon, White Mts., *Duran* 2681 (C); Owens Valley,

Horn 2850 (C); Inyo Co., *Austin* (C); Lone Pine, *Jones* in 1927 (P). Mono Co., Sherwin Grade, *Munz* 11,077 (P). Lassen Co., Honey Lake, *Brandegee* in 1892 (C); Bloody Canyon, *Chestnut* and *Drew* 717–1886 (C); 10 mi. south of Amedee, *Jones* 9972 (P). NEVADA: Washoe, below Boca, *Jones* 9943 (P); 10 mi. northeast of Reno, *Munz* 11,100 (P); Empire City, *Jones* 3969a (P). Humboldt Co., Pine Forest Mts., *Taulor* and *Richardson* 50 (C). Ormsby Co., King's Canyon, *Baker* 1234 (C, P). Esmeralda Co., Candelaria, *Shockley* 242 (C); Carson City, *Jones* 9910 (P) in part; Winnemucca, *Jones* in 1881 (P). IDAHO: Canyon Co., Big Willow, *Macbride* 163 (Univ. Wyo.). Lemhi Co., Salmon, *Payson* 1779 (Univ. Wyo.). Washington Co., Weiser, *Jones* 9914 (P); Dry Soil, St. Anthony, *Merrill* and *Wilcox* 862 (U.S., Univ. Wyo.), *Merrill* and *Wilcox* 822 (U.S., Univ. Wyo.), *Merrill* and *Wilcox* 952 (U.S.). Blaine Co., Picabo, *Macbride* and *Payson* in 1916, 2984 (P). Canyon Co., Nampa, *Macbride* 1069 (P). Elmore Co., King Hill, *Nels.* and *Macb.* 1093 (P); Blackfoot, *Jones* in 1909 (P). Custer Co., Challis, *Macb.* and *Payson* 3213 (P). WASHINGTON: Wilson Creek, *Sandberg* and *Leiberg* 7161 (P).

Gilia Wilcoxii is a form very closely related to *G. filifolia* var. *sparsiflora* and it may merge with that species to some extent. It is so closely related that Macbride preferred to relegate *G. Wilcoxii* to synonomy, Cont. Gray Herb., n.s. **49**: 58, 1917. Earlier, Nelson and Macbride Bot. Gaz. **61**: 35. 1916, placed the name as a synonym of *G. floccosa*, but because of the uncertainty surrounding that name, it is difficult to know just what is Nelson's late understanding of *G. Wilcoxii*.

In 1928 Dr. P. A. Munz collected near Reno two distinct forms growing together without any indication of intergradation. In habit they were very much alike, but one form *G. Wilcoxii*, (Munz 11,100) had large bright blue flowers, and 3–5-parted leaves, while the other *G. filifolia* var. *sparsiflora* (Munz 11,101) had small pale blue flowers and entire or 3-parted leaves. Mr. Jones also collected these two forms in Empire City in 1882 and made a note of their growing together on this collection. These field observations show clearly that there are these two distinct forms in this area. In the herbarium material I have studied, I have found two sheets with both forms mounted together as the same collection; Carson City, *Jones* 9910 (P); Amedee, Calif., *Davy* 3408 (C). Although *G. Wilcoxii* and *G. filifolia* var. *sparsiflora* seem to be distinct, due to apparent intergradation, there are no characters that will in all cases serve to separate the two forms. Although var. *sparsiflora* usually has flowers about 7½ mm. long, and mostly entire leaves, and *G. Wilcoxii* usually has flowers 11 or 12 mm. long and 5-parted leaves, there are many intermediate sheets to make identification difficult.

Some collections of *G. Wilcoxii* suggest *G. virgata* indicating close relationship to that species: Benton, Mono Co., Calif., *Hall* 10,647 (P). A sheet from the White Mts., Esmeralda Co., Nevada, *R. S. Ferris* 674 (C) is a unique sheet that remotely suggests *G. virgata;* the unusual appearance may be due to the alt. (10,500 ft.) at which it grew. Unfortunately the type sheets of *G. Wilcoxii* are examples of the small flowered race that are very close to var. *sparsiflora* in size of corolla and are among those sheets that must be looked upon as near intergrades between the forms.

Species incertae et inquirendae

Hugelia lanata Lindl. Jour. Lond. Hort. Soc. 3, p. 74, 1848.

Because the type is not available, because the description might refer to any of several forms, and because the type locality "America meridionali (Mexico)" is so indefinite; I am unable to definitely refer this name to any form.

Pomona College
Claremont, Calif.

The anatomy of the leaf of Zeugites munroana, an anomalous grass

RALPH W. McCOY

(WITH PLATE 24)

A typical grass leaf consists essentially of two parts, a base and a blade. The former is developed into an amplexicaul sheath which may be open to the base, or closed and tubular for all or much of its length. The blade is bifacial and possesses one series of vascular bundles. A small ligular prolongation of the sheath at the insertion of the blade is also present in most species. In a few broad-leaved tropical grasses such as *Orthoclada*, *Pharus*, *Phyllorachis*, and *Zeugites*, however, a petiole-like stalk is inserted between the blade and sheath.

The parts of the grass leaf are variously interpreted by present day morphologists. Bugnon (1921) contends that the blade is equivalent to the leaf-base of the dicotyledon and that the sheath of the grass leaf is a new structure, having no equivalent in dicotyledonous plants. Arber (1918, 1923) upholds the phyllode theory which states that the blade and sheath of the grass leaf correspond to the petiole and base of the dicotyledonous leaf. The common theory, mentioned by Hitchcock (1922), is that the sheath, petiole, ligule, and blade of the grass leaf are homologous to the leaf-base, petiole, stipules, and blade, respectively, of the dicotyledonous leaf.

The interpretation of the petiole-like stalk, in those species in which it occurs, seems to be the thing of critical significance in comparing these theories. This structure is probably more definitely developed in *Zeugites* than in any other known genus of grasses; and, although its nature might be expected to throw some light on the general problem, it seems that no anatomical study of the leaf of this genus has ever been made. An abundance of good living material of *Zeugites munroana* Hemsl.[1] has made possible a study which has revealed some facts not previously reported.

Inasmuch as the word *petiole* is not a clearly defined anatomical term, it seems best to apply it to the structure in question, even though it may not be the homologue of the petiole of the leaf of dicotyledons. Its presence gives rise to the following questions: (a) Does the anatomy of the petiole differ in any way from that of the blade or sheath? (b) What relationship exists between the anomalous form of the leaf and its venation?

[1] The plants used in this study were grown in the University greenhouse from seeds collected by Dr. Paul Weatherwax near Antigua, Guatemala.

(c) How could all four parts, sheath, ligule, petiole, and blade, have come from a single primordium in the bud?

The literature on the anatomy of the grass leaf is extensive, but the petiole has received little attention. Pée-Laby (1898) was interested in the anatomical characteristics of the leaves of the Gramineae which would have taxonomic value and endeavored to group the grasses of France according to these characteristics. He summarized the work done before 1898, mentioning, among others, the studies of Palisot de Beauvois, Hingshausen, and Duval-Jouve. Beauvois (1812) supported Linnaeus' theory that all grass leaves have an analogous structure and are composed of the same parts. Hingshausen (1865) attempted to classify the Gramineae by the nervation of the leaves and was the first to detect the communication between the parallel veins. Duval-Jouve (1875) was interested in comparative anatomy for taxonomic purposes. Brandis (1907) discussed the structure of various bamboo leaves, but ignored the petiole which is well developed in a number of genera of this group. In Bugnon's comprehensive work (Bugnon, 1921) on the leaves of grasses only a few lines are devoted to the petiole, and they do not touch the significant problems involved.

Goebel (1905) summarized the work done on leaf development up to 1894, making special mention of Steinheil, Schleiden, Trécul, and Eichler. Steinheil (1837) concluded that a leaf grows from above downwards and that the oldest part is at the tip. In a compound leaf, however, the upper leaflets are the youngest. Schleiden (1843) held that the leaf shoots out from the axis, and that the tip is the oldest and the base the youngest. Trécul (1853) noted that the process of leaf-formation may be dissimilar in different plants. Some leaves were observed to be acropetal and others basipetal, while many developed from the middle both upwards and downwards. He stated that the leaf-sheath was the first to arise, but his error was corrected by Eichler (1861) who found that the sheath was formed by intercalary growth out of the base of the leaf.

Goebel contended that those "parts which have the earlier functions to perform appear the earliest." In general, the tip of the monocotyledonous leaf is the oldest and further growth is basipetal and intercalary. He regarded the petiole as nothing more than a narrowed or constricted portion of the lamina, and found that a definite relationship existed between conformation of the leaf and the course of its veins.

GENERAL CHARACTERISTICS OF THE LEAF

The foliage leaf of *Zeugites munroana* consists of blade, petiole, ligule, and sheath. The mature blade is 1.5 to 3 cm. long, and 5 to 10 mm. wide.

It is ovate-lanceolate and rounded at the base, and is separated from the open sheath by a slender petiole whose length is usually about one-fourth that of the blade.

The petiole exhibits marked longitudinal differentiation (Pl. 24, fig. 1). The middle portion is darker in color than either extremity and has a flattened adaxial surface. The distal end of the stalk is terete, and by curvature of this upper terete portion the blade is able to assume various positions with reference to environmental conditions. The proximal end is oval in cross-section and it also is occasionally flexed.

The ligule is an erect outgrowth from the inner surface of the sheath, and is continuous with the thin overlapping edges of the leaf-base. The continuity of the ligule and these thin edges, both of which are somewhat hirsute, gives a slight hooded effect to the upper end of the sheath.

The leaf is convolute in the bud (Pl. 24, fig. 2) but there is no definite relationship between the overlapping in the blade and that of the sheath. In other words, the blade of one particular leaf may be wrapped to the right while its sheath is wrapped to the left, or vice versa; or both may be coiled with the same edge inward.

Apart from the usual bulliform and guard cells, the cells of both the upper and lower epidermis are remarkably uniform. They consist of two classes of cells: (a) the elongated cells with undulating edges, which cover most of the leaf surface, and (b) the smaller polygonal cells with straight edges found at the basal region of the lamina.

VENATION

Different methods of preparing the whole leaf for study were tried, but only one of these proved successful. The best results were obtained by severing the petiole, flattening the sheath, and then treating the two parts separately. These were decolorized, stained, and cleared for examination at low magnification. After the chlorophyll had been removed with alcohol, the blade and sheath were stained in anilin safranin for twenty-four hours, destained and dehydrated with alcohol, changed to xylol and mounted in balsam.

The vascular system of the blade consists of a midrib, and usually six other longitudinal veins almost as large, together with numerous distinctly smaller ones. By diverging at the base and converging at the tip of the blade, these veins become arcuate (Pl. 24, fig. 3). The small nerves traverse the spaces between the large ones, varying in number from one to eight in each space in the middle portion of the blade. As the blade narrows toward the tip and base, the slender nerves anastomose and become fewer in number. Eight of them enter the petiole from the lamina. Numerous

conspicuous cross-veins complete the vascularization of the blade. The diverging and converging arcuate nerves, with the anastomosing cross-veins, cause this leaf blade to simulate the netted-veined leaves of dicotyledons.

Cross-sections of the blade show that each longitudinal nerve consists of a vascular bundle and two girders of sclerenchymatous fibers, one on the adaxial and the other on the abaxial side (fig. 4). These fibrous strands form bars of hard tissue which add strength and rigidity to the leaf. The bundle is enclosed in a sheath of two portions: an outer ring of large, clear, parenchymatous cells, and an inner sheath of thick-walled and strongly lignified cells. The outer sheath, however, is interrupted by the fibrous girder on the abaxial side of the leaf.

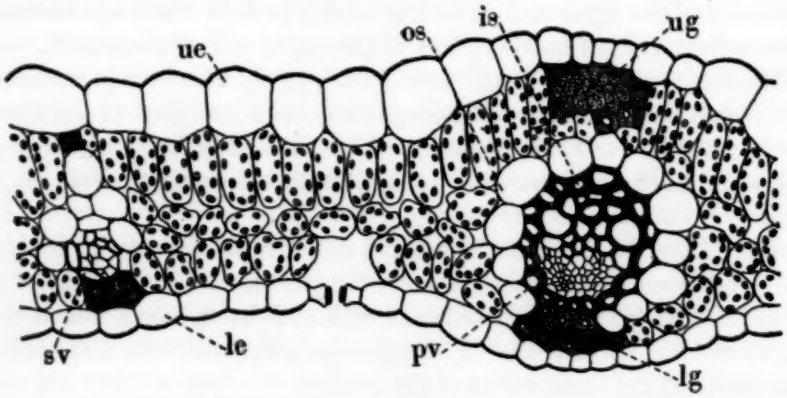

Fig. 4. A portion of a cross-section of the blade to show vascular structure. *ug*, upper girder; *lg*, lower girder; *os*, outer portion of bundle sheath; *is*, inner portion of bundle sheath; *pv*, primary vein; *sv*, secondary vein; *ue*, upper epidermis; *le*, lower epidermis.

The midrib and the six large nerves observed in the blade are also present in the sheath. They extend almost parallel from the base upward and converge in the upper region to enter the petiole. Between each pair of large nerves there is only one small vein, but two or three small ones lie between the edges of the sheath and the outermost large nerves (Pl. 24, fig. 1, s). These slender outer veins unite to form a single strand which enters the petiole. Small cross-veins occur in the leaf-sheath, but they are not as numerous here as in the blade.

The longitudinal veins in the sheath are also reinforced by fibrous girders, which are more prominent on the abaxial than on the adaxial side of the bundle. In the central upper portion of the sheath, however, the vascular strands do not come in contact with the girders. The fibers lie just beneath the epidermis while the veins are embedded in the thickened mesophyll.

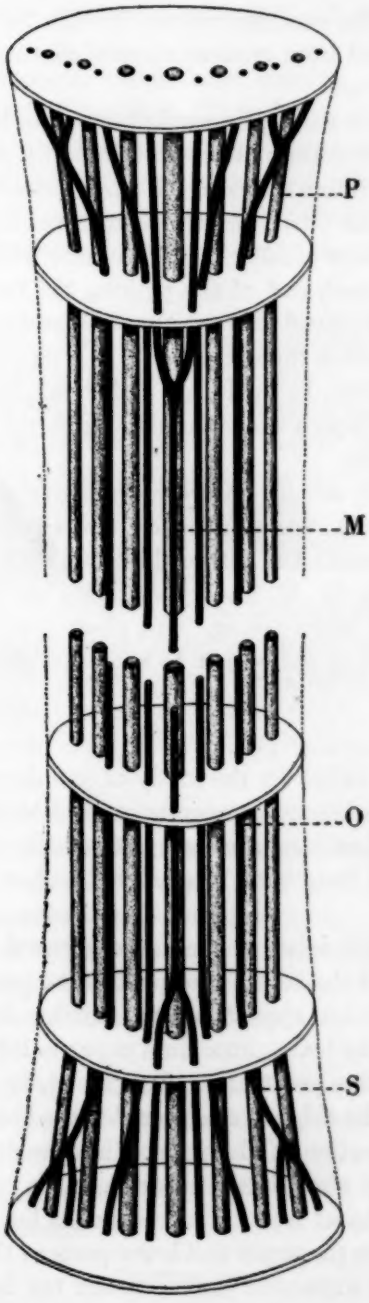

Fig. 5. A diagram of the vascular system of the petiole (greatly shortened). *p*, primary vein; *s*, secondary vein; *o*, the single bundle formed by the union of the two outer slender veins; *m*, the single bundle formed by the union of the two middle slender veins.

In order to trace the vascular system through the petiole, several series of slides were prepared from cross-sections of mature leaf-stalks and from young leaves in the bud.

The midrib and the six large nerves observed in both blade and sheath continue without change through the leaf-stalk (fig. 5, p). They lie parallel and close together, forming a crescent in cross-section. Eight of the slender nerves enter the petiole both from the sheath and from the blade (fig. 5, s). In cross-section, these smaller veins alternate with the larger nerves. A short distance from each end of the petiole, the two outermost pairs of small veins unite and extend through the stalk as single strands (fig. 5, o). The six small veins which then remain, lie in a separate group next to the dorsal side of the petiole. In the longer leaf-stalks, the two middle slender veins usually join to form a single bundle (fig. 5, m). Cross-venation does not occur in the petiole.

Fibrous girders do not lie immediately above or below the vascular strands in the leaf-stalk. Some sclerenchyma is present, however, in the ground tissue just beneath the flattened adaxial surface of the middle portion of petiole (Pl. 24, fig. 6). The upper terete end of the stalk does not possess sclerenchyma when young. This absence of strengthening tissue enables the distal part of the petiole to bend and give the leaf a more advantageous position.

ONTOGENY

The best method found for the study of leaf development was to dissect the buds under a binocular microscope and to observe them at high power. All stages in leaf-formation were studied in this way. Further information was gained from both longitudinal and cross-sections of young leaves in the bud.

The leaf primordium arises as a lateral outgrowth from the meristematic tissue at the end of the stem. That part of the primordium which is to become the apex of the leaf appears at first. Further development is basipetal and intercalary. The leaf-primordium expands laterally until it almost surrounds the vegetative point like a ring (Pl. 24, fig. 7).

In the beginning the ridge of embryonal tissue shows neither blade nor sheath. The upper portion of the primordium finally becomes more expanded than the very short basal region, and, as growth continues, the lower portion of the basal segment also expands laterally, leaving a constricted region between the upper and lower parts of the leaf (Pl. 24, fig. 8). The upper and lower expanded parts become the blade and sheath, respectively, and the narrow constricted region forms the leaf-stalk (Pl. 24, fig. 9). This stalk is at first crescent-shaped in cross-section, but later

thickens by an extended period of secondary cell division in its ground tissue.

The procambial strands, which later develop into the longitudinal veins, appear in the leaf primordium. They lie parallel and close together at first, but the subsequent lateral expansion of the blade and sheath spreads them farther apart in those regions. As a result of this intercalary and basipetal leaf development, the venation of the blade becomes arcuate, and the close approximation of the veins in the petiole is not altered.

SUMMARY

1. The foliage leaf of *Zeugites munroana* affords a good example of a petiole inserted between the blade and the sheath.

2. The leaf is convolute in the bud, but there is no definite relationship between the overlapping in the blade and that of the sheath. The blade may be wrapped to the left and its sheath to the right, or vice versa; or both may be coiled with the same edge inward.

3. Seven large primary veins, which maintain their unity, extend through the sheath, petiole, and blade.

4. Many small secondary veins extend through the blade in the spaces between the large primary veins. These secondary strands begin to anastomose as they near the petiole, five or six of them passing through the stalk in a group apart from the larger nerves.

5. The apex of the leaf is the oldest and further growth is basipetal and intercalary.

6. The blade and sheath are differentiated by the lateral expansion of the upper and lower portions of the leaf during development.

7. The petiole is intercalated between the blade and sheath, or comes from that part of the primordium between the two.

8. The longitudinal veins, which appear as procambial strands in the leaf-primordium, lie parallel and close together at first, but the subsequent expansion of the blade and sheath spreads them farther apart in those regions.

The writer wishes to express his appreciation to Dr. Paul Weatherwax, under whose direction the work was carried on, and to whom he is greatly indebted for advice and criticism.

INDIANA UNIVERSITY
BLOOMINGTON, INDIANA

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Explanation of plate 24

Zeugites munroana

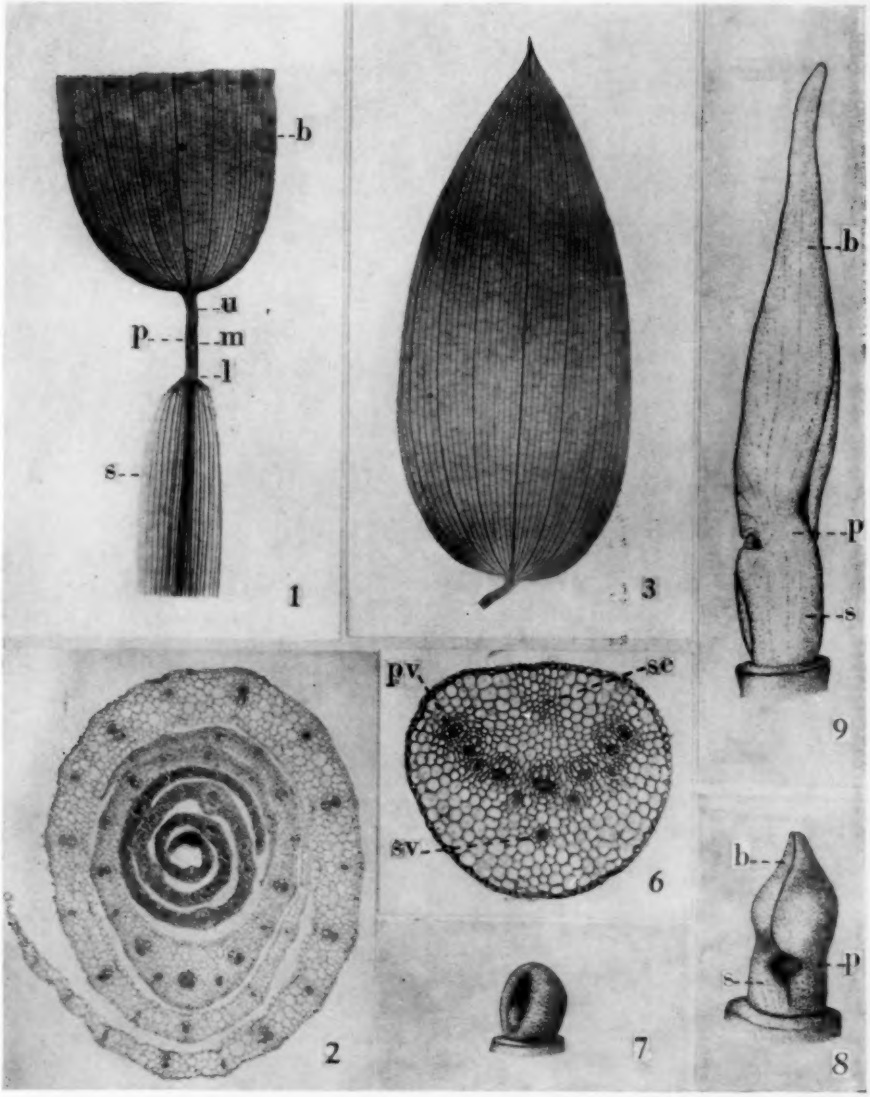
Key to all figures. *b*, blade; *p*, petiole; *u*, upper terete end of petiole; *m*, portion of petiole having flattened adaxial surface; *l*, lower end of petiole which is oval in cross-section; *s*, sheath; *pv*, primary vein; *sv*, secondary vein; *sc*, sclerenchymatous tissue.

Figs. 1, 3. Portions of leaf decolorized, stained, and cleared, showing petiole and venation.

Fig. 2. Cross-section of bud which shows convolute vernation.

Fig. 6. Cross-section through middle portion of young petiole.

Figs. 7–9. Consecutive stages in leaf development.



MCCOY: ZEUGITES

Lemanea grandis (Wolle) Atk. rediscovered after forty years

ROBERT B. GORDON[1]

In 1877 a species of freshwater red algae new to science was discovered in the vicinity of Bethlehem, Pa. by Rev. Francis Wolle, who described it under two generic names, both wrongly applied. Another collection of the same species was made in the neighboring state of Delaware about ten years later. For over forty years there has been no published record of its occurrence elsewhere. Not that it is one of those microscopic plants which can be easily overlooked, because it grows in olive-brown tufts or clusters of thalli an inch or more in length, attached to rocks in the clear waters of mountain brooks and rivers.

It is with much satisfaction that we can announce another locality for this apparent rarity of the plant kingdom, in Western New York State, where the Allegheny River makes a sharp bend in its course, south of the village of Quaker Bridge. It has also been found seven or eight miles to the east on a small tributary known as Quaker Run, in the Allegany State Park (Mathews, 1932).

Species of Rhodophyceae or "red algae" in fresh water are of such infrequent occurrence that any new locality record should be worthy of note. According to G. M. Smith (1933) there are only six freshwater genera of the larger sub-class Florideae, comprising some twenty-three species, found in the United States. Of these, ten species belong to the genus *Batrachospermum* and eight are species of *Lemanea*, seven of which are known from two or more stations.

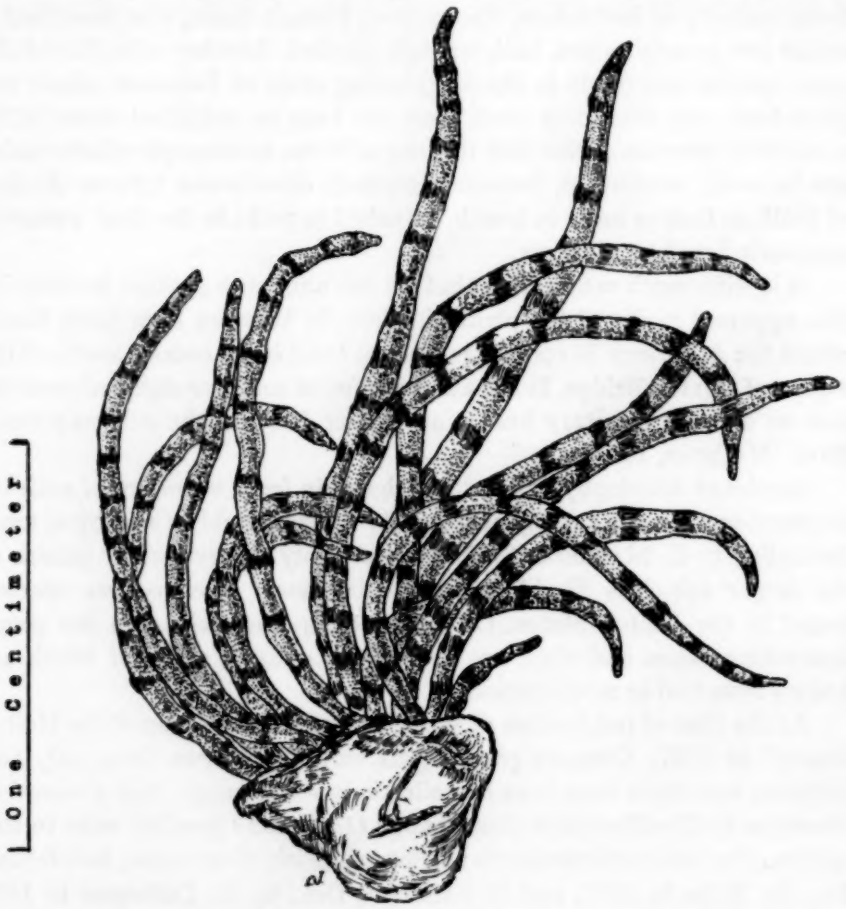
At the time of publication of Wolle's "Freshwater Algae of the United States" in 1887, *Lemanea grandis* was certainly known from only two stations, and there have been no collections since, except that a record of *Tuomeya* by Needham and Strausbaugh (1930) may possibly refer to this species. The two stations were in shallow, sluggish, river water, Bethlehem, Pa., by Wolle in 1877, and at Falkland, Del., by A. Commons in 1886 (Atkinson, 1931).

Wolle described the specimens which he collected as a new species of *Tuomeya*, a genus made by Harvey in 1858. G. F. Atkinson (1890) furnished the following important notes about Wolle's original material: "I have examined specimens of this species from Wolle's herbarium and from Rabenhorst's Alg. Europ, No. 2538, and find it to be a *Lemanea*. Through the kindness of Dr. W. G. Farlow I have had the opportunity of examining

[1] Papers from the Department of Botany, the Ohio State University, No. 342.

specimens of *Tuomeya fluviatilis* Harv., from Harvey's Herbarium. It is very different from Wolle's *Tuomeya grande* (*Entothrix grande* Wolle). I have made careful dissections and find Wolle's *Entothrix* is identical with characters of the subgenus *Lemanea*."

Lemanea and *Tuomeya* . . . may be distinguished from each other by



Lemanea grandis (Wolle) Atkinson. Habit sketch by Louis Jacobson.

the differentiation into nodes and internodes in *Lemanea* and the lack of them in *Tuomeya* (Smith, 1933). The subgenus *Eulemanea* to which *L. grandis* belongs is recognizable by antheridial zones that encircle the thallus in an even transverse band or belt at the nodes (see figure). The only other species of *Lemanea* found in New York State is *L. fucina* Bory, in which the antheridial zones are more or less warty, and the antheridia are con-

fined to these protuberances, which are not usually in lateral contact with one another, an external characteristic of the subgenus *Sacheria* (Atkinson, 1931).

The drawing which accompanies this article shows the appearance of a tuft of thalli in the summer condition. The specimen from which the drawing was made was collected in the Allegheny River below Quaker Bridge, N. Y., which is located in the Allegany Indian Reservation. Dr. Robert E. Coker, Director of the Allegany School of Natural History, called my attention to this plant in 1930, having discovered it the previous summer. L. A. Kenoyer, the botanist, noted "the occurrence in Quaker Run near the school and in places along the Allegheny River of *Tuomeya grande* (or a closely related species)" in his report to the Director in 1929.

Duplicate material from the latter locality has been sent to Prof. Dr. H. Skuja, of the Botanical Institute at the University of Riga, Latvia. Dr. Skuja made the following comment: ". . . you have determined correctly the *Lemanea* as *L. grandis* (Wolle) Atkinson. Indeed this *Eulemanea* is characterized very well by its low stout box-shape and its very large roundish carpospores. Otherwise it resembles closely *L. australis* Atkins., which however contains more elongated and somewhat smaller carpospores." (Translation from letter dated February 20, 1934.)

Department of Botany
Ohio State University

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Scrophulariaceae of the Northwestern United States—II.

Pedicularis of the Group Bracteosae

FRANCIS W. PENNELL

The group of *Pedicularis bracteosa*, which as a section of that genus may be called the Bracteosae, occurs wholly in the northwestern United States. Its members are closely similar in habit, being erect, fleshy-stemmed plants with leaves deeply once pinnatifid and so wide as to be often equilaterally triangular in their general outline. In strong contrast to the leaves, the bracts are short, wide, and nearly or quite entire. The calyx-lobes are five, and prominently developed. The corolla, either yellow or purple or combining both colors, has the galea raised somewhat above the anterior lip and terminating bluntly or in a sharp tip or slight beak. The capsules are short, with both cells relatively well developed. The seeds are reticulate, or longitudinally ridged or slightly winged.

It is not surprising that plants so alike in aspect and nearly associated in range should have long passed as a single species. *Pedicularis bracteosa* was established by Bentham in 1838 for a plant collected by both Drummond and Douglas in the Canadian Rocky Mountains. In 1886 Gray recognized the distinctness of *P. canbyi* from the Mission Range of northwestern Montana, and in 1907 Rydberg described *P. siifolia*, also from western Montana and the only other species with beaked galea. Only one segregate has ever been proposed from the remainder of the group, although there exist outstanding differences in the degree of union of and the occurrence of glandularity on the calyx-lobes, the character of the pubescence, and the color of the corolla; curiously enough, *P. montanensis* Rydb., described from Montana in 1897, proves to be identical with typical *bracteosa*. Analysis shows that among these plants with beakless galea, there are about seven species awaiting scientific recognition.

Although it has been several years since my first detection of these entities, their description has been withheld until after the expedition of 1931 into the northwestern states, when nearly all of these species were seen in flower. Next, it was my intention to embody the account of them in a larger study of "The American Species of Pedicularis," but the necessity of completing in the near future other tasks has caused such delay that it appears advisable to present now this limited treatise of the immediate group of *Pedicularis bracteosa*.

Specimens have been seen from many herbaria, to the curators of which I am indebted. In a later paper these herbaria will be enumerated, and specimens cited so as to portray accurately the range of each species. At present I will merely acknowledge my special obligations to the New York

Botanical Garden, where are the types of the species described by the late Dr. Per Axel Rydberg; to the United States National Herbarium, ever the most representative collection of the United States and which contains the herbarium of Charles V. Piper; to the Rocky Mountain Herbarium of the University of Wyoming, under the care and stimulus of Professor Aven Nelson, and where the late Dr. Edwin B. Payson studied; and to the State College of Washington, where Dr. Piper long worked and where until recently Dr. Harold St. John was continuing his labors. I have especially appreciated the critical assistance of Dr. St. John.

Opportunities for field study were made possible in 1915 by the New York Botanical Garden, and in 1931 by the Academy of Natural Sciences, aided by a grant from the National Research Council. On the earlier trip to the central Rocky Mountain states *Pedicularis paysoniana* was repeatedly seen. While on the latter journey through the northwestern states nearly all the remaining species of the group were collected and studied.

KEY TO SPECIES

Galea abruptly strongly deflexed near apex, beakless.

Lobes of calyx distally filiform, glandular-pubescent, the free lateral lobes longer than their united basal portions.

Corolla dark red throughout, 20 mm. long; glands of calyx-lobes large, blackish; bracts 15–20 mm. long, lancolate with caudate tip, much exceeding the calyx. 1. *P. atrosanguinea*

Corolla purple or partly yellow; glands of calyx-lobes small, pale; bracts shorter.

Corolla 13–16 mm. long, the anterior lip ciliolate; capsule 2–3 mm. long, light brown; bracts oval, with caudate tips. 2. *P. bracteosa*

Corolla 18–20 mm. long, the anterior lip not ciliolate; capsule 9–11 mm. long, dark brown; bracts lanceolate-caudate. 3. *P. paddoensis*

Lobes of calyx lanceolate to linear, not or scarcely glandular.

Calyx-lobes linear, the free lateral lobes longer than their united basal portions.

Inflorescence glabrous or nearly so; free lateral calyx-lobes less than twice as long as the united basal portions; corolla greenish-yellow. 4. *P. flavida*

Inflorescence villose (except at times in *P. Thompsonii*); calyx-lobes usually more than twice as long as their united basal portions.

Galea in anthesis raised little above the anterior lip, and usually enfolded by it; leaf-blades with 6 or 8 pairs of wider dentate segments; roots tuberous-thickened; corolla greenish-yellow. 5. *P. pachyrhiza*

Galea in anthesis raised well above the anterior lip; leaf-blades with 8 to 12 pairs of narrow doubly and sharply toothed segments.

Corolla pale yellow; bracts (except the lowermost) lanceolate-caudate; roots not tuberous-thickened. 6. *P. Paysoniana*

Corolla with galea purple and the anterior lip yellow; bracts (except the

lowermost) ovate, rather abruptly narrowed to a more slender caudate tip; roots slightly tuberous-thickened. 7. *P. Thompsonii*

Calyx-lobes triangular-lanceolate, the free lateral lobes shorter than their united basal portions; corolla either wholly yellow or with purple galea. 8. *P. latifolia*

Galea less sharply decurved, cuneately narrowed to an acute, slightly beaked apex; calyx-lobes united much higher laterally than medianly; corolla greenish-yellow.

Anterior lobes of corolla oval, entire or nearly so; bracts with caudate tip about as long as the oval body; inflorescence villose to glabrate; stem 3–7 dm. tall, the roots tuberous-thickened. 9. *P. siifolia*

Anterior lobes of corolla flabellate, erose-denticulate; bracts with caudate tip shorter than the widely ovate body; inflorescence villose; stem 1–1.5 dm. tall, the roots not tuberous-thickened. 10. *P. Canbyi*

1. **Pedicularis atrosanguinea** Pennell & Thompson, sp. nov.

Roots slightly tuberous-thickened. Stem 3–7 dm. tall, glabrous below the inflorescence. Leaves alternate, mostly cauline, the basal on long petioles, the cauline nearly sessile, the blades 6–13 cm. long, over 2/3 as wide, bipinnatifid, divided nearly or quite to the midrib into 8 to 12 pairs of segments which are nearly regularly serrate or dentate. Inflorescence nearly spicate, densely flowered, 9–15 cm. long, the rachis, bracts and calyces moderately lanose with glandless hairs, the calyx-lobes pubescent with black-headed glands. Bracts 15–20 mm. long, lanceolate-caudate, entire or distally slightly serrate. Pedicels less than 2 mm. long. Calyx 9–12 mm. long, the posterior sepal about 2/3 the length of the others, as a free lobe projecting 2–3 mm. from the posterior cleft of the calyx-tube, the lateral sepals united slightly higher, even, free 5–6 mm., linear-filiform, attenuate, lobes all entire. Corolla about 20 mm. long, dark blood-red (drying nearly black); the galea erect, distally decurved, at apex abruptly truncate, without teeth; the anterior lip ascending but so much shorter than galea as not to close the throat, the anterior lobes somewhat erose. Filaments and anthers glabrous. Capsule 12 mm. long, flattened, 7 mm. wide, with decurved tip, the cells slightly unequal, dehiscing to base on upper side and opening anterior cell by a split of the septum. Seeds 3 mm. long, with several low transversely lined wings.

(Caulis 3–7 dm. altus, glaber; folia alterna, 6–13 cm. longa, 4–10 cm. lata, segmentis serratis dentatisve insecta; inflorescentia pilis glanduliferis nigris obtecta; calycis segmenta 5 lineari-filiformia; corolla 20 mm. longa, atrosanguinea, galea erostrata; capsula 12 mm. longa; semina 3 mm. longa.)

Type, openings in coniferous forest, slope of second peak of Mount Angeles, Clallam County, Washington, altitude 1500–1600 meters (5000–6000 feet), collected in flower and fruit August 9, 1931 by F. W. Pennell and J. W. Thompson, no. 15822; in Herb. Academy of Natural Sciences of Philadelphia.

Moist wooded slopes and open meadows, Olympic Mountains, northwestern Washington.

This is a handsome plant, with flowers remarkable for the peculiar color to which the name "atrosanguinea," meaning "dark blood," is especially appropriate.

2. PEDICULARIS BRACTEOSA Bentham.

Pedicularis bracteosa Benth.; Hook., Fl. Bor. Amer. **2**: 110. 1838. "Shady alpine woods of the Rocky Mountains. Drummond. N. W. Am. Douglas (last journey)." Type, collected by Drummond in "Saskatchewan" (by which would surely be meant the Rocky Mountains of the present Alberta), seen in Herb. Kew Gardens. It shows well the lanceolate-attenuate, glandular-pubescent calyx-lobes of the plant considered.

Pedicularis montanensis Rydb. in Bull. Torrey Bot. Club **24**: 292. 1897. "Type: J. H. Flodman, no. 796, from Little Belt Mountains, nine miles from Barker [Montana], August 18, 1896." Type seen in Herb. New York Botanical Garden; isotype in Herb. Academy of Natural Sciences of Philadelphia. Rydberg identified *P. paysoniana* as true *bracteosa*, and described again Bentham's original plant under the present name.

Shaded woodland and cool grassy slopes, mountains, Rocky Mountains and contiguous chains, Alberta and British Columbia to western Montana and the Wallowa Mountains of northeastern Oregon.

3. **Pedicularis paddoensis** Pennell, sp. nov.

Roots slightly tuberous-thickened, 6 mm. in diameter. Stem 3–6 dm. tall, glabrous below the inflorescence. Leaves alternate, mostly cauline, the basal with moderately long petioles, the cauline nearly sessile, the blades 10–12 cm. long, nearly as wide bi- or tri-pinnatifid, divided nearly or quite to the midrib into 10–12 pairs of segments, which are doubly serrate-dentate. Inflorescence essentially spicate, densely flowered, 8–15 cm. long, the rachis, bracts and calyces glandular-puberulent or slightly hairy. Bracts 15–20 mm. long, lanceolate, caudate, distally slightly serrate. Pedicels less than 1 mm. long. Calyx 10–12 mm. long, the posterior sepal slightly the shortest, as a free lobe projecting 4–6 mm. from the deep posterior cleft of the calyx-tube, the lateral sepals nearly even, free 4–7 mm. from apex, lobes all entire. Corolla 18–20 mm. long, purple or sometimes at least the lip yellow; the galea erect, distally decurved, at apex truncate, without teeth; the anterior lip ascending, shorter than the galea and leaving the throat open, the anterior lobes merely erose. Filaments and anthers glabrous. Capsule 9–10 mm. long, dark brown. Seeds 3 mm. long, the pale testa slightly ridged, and prominently cross-lined.

(Caulis 3–6 dm. altus, glaber; folia alterna, 10–12 cm. longa, 9–11 cm. lata, segmentis duplicate serrato-dentatis insecta; inflorescentia glandulo-puberulentia; calycis segmenta 5 lineari-filiformia; corolla 18–20 mm. longa, tota purpurea vel labio anteriore flava, galea erostrata; capsula 9–10 mm. longa; semina 3 mm. longa.)

Type, moist rich soil in coniferous woodland, bank of Bird Creek, altitude 1700–1800 meters (5500–6000 feet), Mount Adams, Yakima County, Washington, collected in late flower and fruit July 31, 1931, by F. W. Pennell, no. 15738; in Herb. Academy of Natural Sciences of Philadelphia.

Moist woods and meadows, upper slopes of Mount Adams (Mount Paddo), Cascade Range, Washington.

4. **Pedicularis flavida** Pennell, sp. nov.

Roots tuberously thickened Stem 3–9 dm. tall, glabrous throughout. Leaves alternate, mostly cauline, the basal with long petioles, the cauline nearly sessile, the blades 5–10 cm. long, nearly as wide, bipinnatifid, divided nearly or quite to the midrib into 10 to 14 pairs of segments, which are irregularly serrate or with again serrate lobes. Inflorescence nearly spicate, rather loosely flowered, 7–15 cm. long, the rachis, bracts and calyces glabrous or sparsely puberulent. Bracts 10–20 mm. long, ovate-caudate to lanceolate, entire or distally slightly serrate. Pedicels less than 1 mm. long. Calyx 8–10 mm. long, the posterior sepal slightly the shortest, as a free lobe projecting 2–3 mm. from the deep posterior cleft of the calyx-tube, the lateral sepals even, free 3–4 mm. from apex, lobes all entire. Corolla 15–18 (–20) mm. long, greenish yellow (pale viridine yellow), or rarely the anterior lip (at base) purple; the galea erect, distally decurved, at apex truncate, without teeth; the anterior lip ascending, shorter than the galea, nearly closing the orifice to the throat, the anterior lobes erose. Filaments and anthers glabrous. Capsule 8–10 mm. long, flattened, 4–5 mm. wide, with decurved tip, the cells slightly unequal, capsule dehiscing to base on posterior side and then splitting septum. Seeds 2.5 mm. long, with several low, transversely lined ridges.

(Caulis 3–9 dm. altus, glaber; folia alterna, 5–10 cm. longa, 4–9 cm. lata, segmentis serratis biserratisve insecta; inflorescentia glabra; calycis segmenta lineari-filiformia; corolla 15–18 mm. longa, ochroleuca, galeā erostratā; capsula 8–10 mm. longa; semina 2.5 mm. longa.)

Type, wet thicket along Elk Lake, Deschutes County, Oregon, altitude 1430–1550 meters (4700–5100 feet), collected in flower July 9, 1931, by F. W. Pennell, no. 15545; in Herb. Academy of Natural Sciences of Philadelphia.

Moist slopes, meadows and open woods, high mountains, Cascade Range of Oregon and Siskiyou Mountains of southern Oregon and northern California.

5. **Pedicularis pachyrhiza** Pennell, sp. nov.

Roots tuberous-thickened, the larger 6–8 mm. in diameter. Stem 4–10 dm. tall, glabrous and slightly glaucous below the inflorescence. Leaves alternate, mostly cauline, the basal on long petioles, the cauline nearly sessile, the blades 10–16 cm. long, 2/3–3/4 as wide, bipinnatifid, divided to the midrib into 6 or 8 pairs of segments, which are doubly crenate-dentate. Inflorescence essentially spicate, densely flowered, 10–15 cm. long, the rachis, bracts and calyces lanose. Bracts 13–25 mm. long, lanceolate-caudate, distally crenate-serrate. Pedicels less than 1 mm. long. Calyx 15 mm. long, the posterior sepal less than 1/2 the length of the others, as a free lobe projecting 1–4 mm. from the

very deep posterior cleft of the calyx-tube, at times hardly evident, the lateral sepals unequal, hardly united higher laterally, antero-lateral pair slightly shorter, postero-lateral pair free 4–9 mm. from apex, lobes all entire. Corolla 15–22 mm. long, greenish yellow; the galea erect, chalcedony yellow, distally decurved at apex, truncate, without teeth; the anterior lip ascending, light green yellow, nearly as long as the galea but hardly closing the throat, the anterior lobes entire and not ciliolate. Filaments and anthers glabrous. Capsule 10–11 mm. long, with decurved tip, the cells slightly unequal, dehiscing to base on posterior side and opening anterior cell by a longitudinal split of the septum (later also dehiscing on anterior side). Seeds not seen.

(Caulis 4–10 dm. altus, glaber; folia alterna, 10–16 cm. longa, 7–12 cm. lata, segmentis duplicate crenato-dentatis insecta; inflorescentia lanosa; calycis segmenta linearia; corolla 15–22 mm. longa, ochroleuca, galeā erostratā; capsula 10–11 mm. longa; semina non visa.)

Type, bushy summit, altitude 1500 meters (5000 feet), Blue Mountains northwest of Elgin, Union County, Oregon, collected in flower July 2, 1931 by F. W. Pennell, no. 15414; in Herb. Academy of Natural Sciences of Philadelphia.

Open glades in woods, Blue Mountains of northeastern Oregon.

6. **Pedicularis Paysoniana** Pennell, sp. nov.

Roots not tuberous-thickened. Stem 3–9 dm. tall, glabrous below the inflorescence. Leaves alternate, mostly cauline, the basal on long petioles, the cauline shortly petioled, the blades 5–15 cm. long, from 2/3 to nearly as wide as long, bi- or usually tri-pinnatifid, divided to the midrib into 9 to 12 pairs of segments which are irregularly toothed or cut into serrate lobes. Inflorescence essentially spicate, densely flowered, 10–30 cm. long, the rachis, bracts and calyces loosely lanate. Bracts 10–20 cm. long, lanceolate, slightly caudate, distally slightly serrate. Pedicels less than 1 mm. long. Calyx 8–10 mm. long, the posterior sepal about 2/3 the length of the others, as a free lobe projecting 2 mm. from the posterior cleft of the calyx-tube, the lateral sepals united little higher (occasionally even half their free length), nearly even, free 4 mm. from apex, lobes all entire. Corolla 20 mm. long, yellow; the galea erect, distally decurved, at apex abruptly truncate and without teeth; the anterior lip ascending but so much shorter than the galea as not to close the throat, the anterior lobes slightly erose, not ciliate. Filaments and anthers glabrous. Capsule 10–11 mm. long, with mucronate decurved tip, the cells slightly unequal, dehiscing to base on posterior side and opening anterior cell by a longitudinal split of the septum. Seeds 4 mm. long, obovoid, reticulate especially with prominent transverse lines.

(Caulis 3–9 dm. altus, glaber; folia alterna, 5–15 cm. longa, 4–14 cm. lata, segmentis dentato-serratis lobatisve insecta; inflorescentia lanosa; calycis segmenta linearia; corolla 20 mm. longa, flava, galeā erostratā; capsula 10–11 mm. longa; semina 4 mm. longa.)

Type, moist slope, mountains near Cottonwood Lake, east of Smoot, Lincoln County, Wyoming, collected in flower August 2, 1923, by E. B. Payson and G. M. Armstrong, no. 3724; in Herb. Academy of Natural Sciences of Philadelphia.

Moist woodland, at altitudes of 2200 to 3600 meters, mountains of the Rocky Mountain system, central Montana southward through Wyoming and eastern Idaho to Colorado and the La Sal Mountains of southeastern Utah.

It is a pleasure to associate with this beautiful and characteristic species of the central Rocky Mountains the names of Dr. and Mrs. Edwin Blake Payson. The untimely death of Dr. Payson in 1927 removed from American taxonomy not only one of its most promising students but the one whose work seemed most likely to aid in the understanding of the Rocky Mountain flora.

7. **Pedicularis Thompsonii** Pennell, sp. nov.

Roots slightly tuberous-thickened. Stem 3–8 dm. tall, glabrous below the inflorescence. Leaves alternate, the basal on long petioles, the cauline shortly petioled or sessile, the blades 8–10 cm. long, from 1/2–2/3 as wide, bipinnatifid, divided to the midrib into 8 to 10 pairs of segments which are sharply toothed and the teeth crenate-serrate. Inflorescence spicate, densely flowered, 10–15 cm. long, the rachis, bracts and calyces loosely lanose or glabrescent (with the latter ciliate). Bracts 10–15 mm. long, ovate, with a narrow caudate, serrate or entire tip. Pedicels about 1 mm. long. Calyx 8–11 mm. long, the posterior sepal 3/5–2/3 the length of the others, as a free lobe projecting 3–5 mm. from the posterior cleft of the calyx-tube, the lateral sepals united farther, nearly even, free 3–7 mm. from apex, lobes all entire. Corolla 16–19 mm. long, purple and partly yellow; the purple galea erect, distally decurved, at the yellow apex abruptly truncate, without teeth; the anterior lip yellow, ascending but so much shorter than the galea as not to close the throat, the anterior lobes slightly erose and at times ciliolate. Filaments and anthers glabrous. Capsule 8–10 mm. long, with decurved tip, the cells slightly unequal, dehiscing to base on posterior side and opening anterior cells mainly by a longitudinal split of septum. Seeds not seen.

(Caulis 3–8 dm. altus, glaber; folia alterna, 8–10 cm. longa, 4–7 cm. lata, segmentis duplicate serrato-dentatis insecta; inflorescentia lanosa glabrescensve; calycis segmenta linearia; corolla 16–19 mm. longa, purpurea vel parte flava, galeā erostratā; capsula 8–10 mm. longa; semina non visa.)

Type, open woods near Wauconda, summit between Tonasket and Republic, Okanogan County, Washington, collected in flower June 29, 1931, by J. William Thompson, no. 7142; in Herb. Academy of Natural Sciences of Philadelphia.

Mountains of northern Washington.

Of uncertain status, and possibly hybrid origin.

8. **Pedicularis latifolia** Pennell, sp. nov.

Roots tuberous-thickened. Stem 4–12 dm. tall, glabrous below the inflorescence. Leaves alternate, mostly cauline, the basal with long petioles, the cauline nearly sessile, the blades 5–20 cm. long, often nearly as wide, paler beneath, bi- or tri-pinnatifid divided nearly to the midrib into 8 to 12 pairs of segments, which are irregularly serrate, toothed or with serrate lobes. Inflorescence nearly spicate, densely flowered, 10–40 cm. long, the rachis, bracts and calyces usually slightly pubescent or slightly lanose. Bracts 11–20 mm. long, lanceolate to ovate, caudate, entire or rarely serrate. Pedicels less than 1 mm. long. Calyx 10–12 mm. long, the posterior sepal much shorter than the others, as a free lobe projecting 3–5 mm. from the deep posterior cleft of the calyx-tube, the lateral sepals even, those of each side united to within 2–4 mm. of apex, but anteriorly united only a little farther than posteriorly, the lobes entire. Corolla 15–18 (–20) mm. long, yellow (often the bend or the entire galea purple); the galea erect, distally decurved, at apex abruptly truncate, without teeth; the anterior lip ascending but so much shorter than the galea as not to close the throat, the anterior lobes entire or slightly erose. Filaments glabrous throughout; anthers glabrous. Capsule 9–10 mm. long, with mucronate decurved tip, the cells unequal, dehiscing to base on posterior side and opening anterior cell by a longitudinal split of the septum. Seeds 3 mm. long, ovoid, finely ridged, with reticulate testa, the longitudinal ridges of which are drawn out in several low, thin wings.

(Caulis 4–12 dm. altus, glaber; folia alterna, 5–20 cm. longa, 3–18 cm. lata, segmentis duplicate dentatis serratisve insecta; inflorescentia pubescentia; calycis segmenta lateralia fere juncta; corolla 15–18 mm. longa, flava vel galea purpurea, galeā erostratā; capsula 9–10 mm. longa; semina 3 mm. longa.)

Type, openings in coniferous forest, Paradise Inn, Mount Ranier, Washington, altitude 1600–1800 meters (5200–6000 feet), collected in flower and fruit August 5–6, 1931, by F. W. Pennell, no. 15786; in Herb. Academy of Natural Sciences of Philadelphia.

Moist open woods and grassy slopes, high mountains of southern British Columbia, Washington and Northern Idaho, from the Cascade Mountains to the Cœur d'Alene Mountains.

9. PEDICULARIS SIIFOLIA Rydberg

Pedicularis siifolia Rydb. in Bull. Torrey Bot. Club **34**: 35. 1907. "Montana: Grant Creek, June 7, 1897, M. J. Elrod, and assistants 97." Type seen in Herb. New York Botanical Garden.

Moist dark woods, mountains of central Idaho, northward to Missoula County, Montana, and westward to Asotin County, Washington.

10. PEDICULARIS CANBYI Gray

Pedicularis Canbyi Gray, Syn. Fl. N. Amer. 2. I: 454. 1886. "Rocky Mountains of Montana, on McDonald's Peak of the Mission Range, at 8400 feet, Canby, 1883." Isotype, W. M. Canby 266, collected July 19, 1883, seen in Herb. Academy of Natural Sciences of Philadelphia.

Mission Range of northwestern Montana.

ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA

Descriptions of ten new hybrid poplars

E. J. Schreiner and A. B. Stout

The ten hydrid poplars here described have been selected as the most promising plants among 69 hybrids which in turn were chosen from a total of approximately 13,000 individual seedlings obtained by hybridizing 34 different types of poplars. Summaries of this breeding project have already been published[1] which record the methods employed, the names of the poplars used as parents, the number of seedlings grown in each hybridization, the basis upon which selections were made, and the particular crosses which yielded selection plants. This paper will be devoted to the ten hybrids which have thus far appeared to be best in respect to (a) vigor of growth in the nursery of the Oxford Paper Company at Frye, Maine, (b) ability to root from cuttings, (c) hardiness, and (d) resistance to disease.

The descriptions are of necessity based on nursery stock and young trees, and hence the sex, the form of the tree, and the character of the trunk can not be given until later when mature trees are seen. It is well known that, for poplars especially, there are decided differences in the appearance of the leaves on vigorous nursery stock and on older trees. Also there are noticeable contrasts in the size and shape of leaves on vigorous end-shoots compared with those of slow-growing, lower, and lateral branches. Also differences in size and shape exist for a series of leaves on the same branch. The following descriptions include consideration of both primary and secondary branches and of the character of the twigs and buds in summer and in winter.

Each of these ten hybrids is being propagated by cuttings to obtain numerous trees all of which are merely branches of the original seedlings with the same individual nature and status. To each of these clones the authors have applied a special horticultural name which has some association with the hybridization project.

Geneva Poplar

Populus Maximowiczii (♀) × *P. berolinensis* (♂)

Summer Characters. *Stems.* Round throughout, somewhat sparsely pubescent except at base of most vigorous shoots, reddish brown toward

[1] The breeding of forest trees for pulpwood. A. B. Stout, Ralph H. McKee, E. J. Schreiner. Jour. New York Bot. Garden **28**: 49–63. 1927.

Results of a project in hybridizing poplars. A. B. Stout and E. J. Schreiner. Jour. of Heredity **24**: 216–229. 1933.

tip, olive green toward base; lenticels white and linear toward tip, pinkish brown and broadly linear or oval toward base, 0.5–3.0 mm. long. *Leaves.* Broadly ovate to oval, apex acute to short-pointed, base obtuse; firm, leathery, rather dark dull green above, glaucous below; margin medium finely crenate, usually 4–5 crenations per cm., glandular, quite strongly undulate; midrib and veins green and sparsely pubescent above (in very young leaves tinted red), green and glabrous below. Petiole round, reddish and sparsely pubescent on upper side, green and glabrous below, lenticellate, 32–44 mm. long. Stipules rather narrow subulate, long pointed, rather early fugaceous. Leaves on secondary shoots, elliptical, apex acute to short pointed, base acute; margin more finely crenate, usually 5–7 crenations per cm. *Buds.* Rather broadly lanceolate, sharp-pointed, 6–10 mm. long, glossy dark reddish brown, viscid, aromatic, appressed.

WINTER CHARACTERS. *Stems.* Round, slightly ridged, slightly pubescent, and greyish brown toward tip, greyish green toward base; lenticels reddish pink, linear toward tip, elliptical to circular toward base; pith somewhat five-sided toward tip, round toward base, light brown, homogeneous. Leaf-scars broadly triangular, decurrent, winged and keeled by short rounded ridges; three prominent bundle-scars. Stipule-scars rather inconspicuous, linear, somewhat curved. *Buds.* Terminal buds ovate. Axillary buds narrowly ovate with acute tips, light brown to dark reddish brown, 8–12×4–6 mm., resinous, viscid, aromatic, appressed.

OXFORD POPLAR

P. Maximowiczii (♀)×*P. berolinensis* (♂)

SUMMER CHARACTERS. *Stems.* Round, somewhat sparsely pubescent, brownish red toward tip, olive green toward base; lenticels white and linear toward tip, pinkish brown and oval toward base, 0.5–4.0 mm. long. Secondary shoots somewhat less red. *Leaves.* Broadly ovate to oval, apex short acute, base obtuse, very slightly cordate at junction of blade and petiole; firm, rather leathery, dull dark green above, glaucous below; margin medium finely crenate, usually 3–5 crenations per cm., glandular, strongly undulate; midrib and basal portion of large veins red and puberulose above, (in older leaves red color restricted to basal portion of midrib) green and glabrous below. Petioles round to broadly oval, red and puberulose above, green and sparsely puberulose below, lenticellate, 30–50 mm. long. Stipules rather small, amost triangular, green, somewhat tardily fugaceous. Leaves on secondary shoots broadly elliptical, apex short acute, base broadly acute to obtuse; margin more finely crenate, usually 5–7 crenations per cm. *Buds.* Lanceolate, 6–10 mm. long, somewhat glossy, red to reddish brown; viscid, aromatic, appressed.

WINTER CHARACTERS. *Stems.* Round, reddish brown and sparsely pubescent toward tip, olive grey or greenish toward base; lenticels pinkish, linear toward tip, elliptical to oval or circular toward base; pith five-sided, light brown and homogeneous. Leaf-scars broadly triangular, decurrent, winged and keeled by short, prominent, rounded ridges; three prominent bundle-scars. Stipule-scars often rather indistinct, linear to narrow V-shaped. *Buds.* Terminal buds ovate; axillary buds broadly lanceolate with narrowly acute tips, 10–14×3–5 mm., reddish brown; resinous, viscid, aromatic, closely appressed.

The GENEVA POPLAR and the OXFORD POPLAR are sister seedlings. The seed parent is *Populus Maximowiczii*, a species of the balsam group, which matures fruit in autumn. The pollen parent, although known under the species name *P. berolinensis*, is usually considered to be a hybrid, but its characters are strongly balsam. These two hybrids are to be classed as balsam poplars; the buds are very resinous and the under surface of the leaves is glaucous white. They resemble, rather strongly, the female parent but they root more readily from cuttings, are more hardy, the leaves on the main shoots are conspicuously less orbicular and more acute, and the leaves on the spur shoots are more elliptical and cuneate. The two differ from each other by slight but rather constant features; for the OXFORD POPLAR, the midrib and veins of the older leaves are more red, the pubescence on the midrib and base of the larger veins is shorter, the petioles are longer, and the winter buds are less broad.

ANDROSCOGGIN POPLAR

P. Maximowiczii (♀)×*P. trichocarpa* (♂)

SUMMER CHARACTERS. *Stems.* Round, slightly ridged toward tip, sparsely pubescent except at base of most vigorous shoots, reddish green with occasional green areas toward tip, olive green toward base; lenticels white and linear toward tip, pinkish-brown and broadly linear or oval toward base, 0.5–3.0 mm. long. Secondary shoots round, not ridged toward tip, somewhat more red. *Leaves.* Elliptical to ovate, apex acute, base obtuse to very slightly cordate in largest leaves; firm, leathery, dull dark green above, glaucous below; margin somewhat finely crenate, usually 4–6 crenations per cm., glandular, quite strongly undulate. Midrib and larger veins reddish and sparsely pubescent above (in oldest leaves practically green), green and more sparsely pubescent below. Petioles round, red above, green below, lenticellate, rather sparsely pubescent on both upper and under side, 25–38 mm. long. Stipules subulate, sharp pointed, green, fugaceous. Leaves on secondary shoots elliptical, apex acute, base acute

to obtuse; margin more finely crenate, usually 6–9 crenations per cm.; veins and petioles less red. *Buds*. Lanceolate, sharp pointed, 8–13 mm. long, glossy, dark reddish brown, viscid, aromatic, appressed.

WINTER CHARACTERS. *Stems*. Round with narrow corky ridges on upper portion, finely pubescent and reddish brown toward tip, olive green toward base; lenticels pinkish-brown, linear toward tip, elliptical or oval toward base; pith five-sided near tip, almost circular toward base, light brown, homogeneous. Leaf-scars prominent, broadly triangular, decurrent, winged and keeled by sharp narrow corky ridges, these ridges extending to the next lower bud except at base of stem; three prominent bundle-scars. Stipule-scars rather prominent, linear to narrow V-shaped and slightly curved, quite long. *Buds*. Terminal buds ovate to oval; axillary buds broadly lanceolate with acute tips dark brown to reddish brown, 8–14 ×3–6 mm.; viscid, aromatic, resinous, appressed.

ROCHESTER POPLAR

P. Maximowiczii (♀)×*P. nigra plantierensis* (♂)

SUMMER CHARACTERS. *Stems*. Round, sparsely puberulose, bright glossy green toward tip (growing tip tinged with red), duller slightly brownish green toward base; lenticels white and linear toward tip, greyish white and oval toward base, 0.5–3.5 mm. long. Secondary shoots more brownish green. *Leaves*. Broadly ovate to oval, apex very short acute, base cordate; firm, rather leathery, dull dark green above, glaucous below; margin medium finely crenate, usually 4–6 crenations per cm., glandular, undulate; midrib and large veins green above and below, somewhat sparsely puberulose above, more sparsely puberulose below. Petioles round, green (on young leaves very slightly tinged with red above), lenticellate, puberulose above, sparsely puberulose below, 25–38 mm. long. Stipules subulate, green fugaceous. Leaves on secondary shoots broadly elliptical, apex very short acute, base obtuse to slightly cordate; margin more finely crenate, usually 5–9 crenations per cm. *Buds*. Broadly lanceolate, sharp pointed, 8–12 mm. long, glossy, green to reddish brown, viscid, aromatic. Closely appressed except at tip of occasional bud.

WINTER CHARACTERS. *Stems*. Round, brown toward tip, olive brown and reticulate toward base. Lenticels pinkish, linear toward tip, elliptical or narrow oval toward base. Pith five-sided, brownish, homogeneous. Leaf-scars broadly triangular, decurrent, with three prominent bundle-scars. Stipule-scars linear to narrow V-shaped. *Buds*. Axillary buds broadly lanceolate with acute tips, brown, 12–16×3–7 mm.; viscid, resinous aromatic, closely appressed except at tip.

The four hybrids described above have *P. Maximowiczii* as a female parent and they strongly resemble this parent as do all the various hybrids which were obtained with this species. The GENEVA POPLAR and the OXFORD POPLAR have the same pollen parent, *P. berolinensis*, and they are very similar in appearance. They differ from the ANDROSCOGGIN POPLAR and the ROCHESTER POPLAR in the following characters: the leaves are somewhat more coarsely crenate; the midrib and veins are glabrous below; and the summer buds are usually slightly shorter. In the winter condition, the stems are slightly ridged toward the tip; the leaf-scars are winged and keeled by prominent, short, rounded ridges; and the stipule-scars are rather inconspicuous.

The ANDROSCOGGIN POPLAR is characterized by its more elliptical leaves; by the corky ridges toward the tip of the winter stems; and by the leaf-scars, which are winged and keeled by sharp, narrow, corky ridges extending to the next lower bud, except at the base of the stem.

The ROCHESTER POPLAR is the most easily distinguished of the four hybrids described above. The more noticeable differences are as follows. In the summer condition, the stems are bright glossy green and puberulose toward the tip, and slightly brownish green toward the base; the midrib and veins of the leaves are green above; and buds are quite green and the tips are occasionally slightly out-curved. In the winter condition the stems are round throughout with practically glabrous tips; the tips of the buds are more noticeably out-curved; and the leaf-scars are not prominently winged and keeled as are those of the other three hybrids.

The ANDROSCOGGIN POPLAR has been very slightly infected by *Melampsora* leaf rust, but there have been no injurious effects for the infection has taken place very late in the season, just prior to the leaf fall. The three other clones have been practically immune to this disease up to the present time.

STRATHGLASS POPLAR

P. nigra (♀) × *P. laurifolia* (♂)

SUMMER CHARACTERS. *Stems*. Round, very slightly ridged toward tip, sparsely puberulose except at base, reddish brown mottled with green above, olive or greyish green somewhat reticulate below; lenticels white and linear toward tip, oval and light brown to grey toward base, 0.5–5.0 mm. long. Secondary shoots round throughout, less red. *Leaves*. Ovate, apex acute or occasionally short acuminate, base obtuse or occasionally very slightly cordate at petiole, firm, medium green above, light green below; margin somewhat coarsely crenate, usually 2–4 crenations per cm., glandular, undulate; veins green above and below, basal portion of midrib

very sparsely puberulose above, glabrous below; petioles slightly flattened, bright red and puberulose above, less red to green and very sparsely puberulose below, lenticellate, 30–45 mm. long. Stipules triangular, sharp pointed, green, tardily fugaceous. Leaves of secondary shoots narrowly ovate to elliptical, apex acute to short acuminate, base obtuse to broadly cuneate; margin somewhat more finely crenate, usually 4–5 crenations per cm. Petioles often less red. *Buds*. Lanceolate, sharp pointed, 6–11 mm. long, glossy, dark brown, very slightly viscid, aromatic; rather loosely appressed.

WINTER CHARACTERS. *Stems*. Round, slightly ridged and greenish brown toward tip, greenish grey toward base; lenticels brownish grey, linear toward tip, oval to circular toward base; pith five-sided, light brown, homogeneous. Leaf-scars triangular to almost cordate, not very strongly decurrent, winged and keeled by rather narrow ridges, on upper portion of stem these ridges run to next lower bud; three prominent bundle-scars. Stipule-scars quite conspicuous, irregularly narrow V-shaped. *Buds*. Terminal buds broadly ovate. Axillary buds lanceolate with acute tips, 6–11×3–4 mm., reddish brown, not resinous or viscid, appressed.

FRYE POPLAR

P. nigra (♀)×*P. laurifolia* (♂)

SUMMER CHARACTERS. *Stems*. Round, with low, well defined ridges toward tip, sparsely puberulose except at base, reddish brown mottled with green above, olive or greyish green somewhat reticulate below. Lenticels linear and white above, oval and light brown or grey below, 0.5–4.0 mm. long. Secondary shoots round, usually not at all ridged, less red. *Leaves*. Ovate, apex acute, base slightly cordate; firm, medium green above, lighter green below; margin somewhat coarsely crenate, usually 3–4 crenations per cm., glandular, undulate; veins green above and below, midrib and basal portions of large veins puberulose or sparsely puberulose above, glabrous below. Petioles slightly flattened, dull red and puberulose above, green and glabrous below, 30–45 mm. long. Stipules triangular, sharp pointed, green, tardily fugaceous. Leaves of secondary shoots narrowly elliptical, apex acute, base obtuse to broadly cuneate; margin somewhat more finely crenate, usually 4–7 crenations per cm. *Buds*. Lanceolate, sharp pointed, 6–10 mm. long, dark brown, very slightly viscid, aromatic, appressed.

WINTER CHARACTERS. *Stems*. Round, slightly ridged on upper portion, reddish brown toward tip, brownish green toward base; lenticels brownish grey, linear toward tip, oval to circular toward base; pith five-sided, light

brown, homogeneous. Leaf-scars triangular to almost cordate, not very strongly decurrent, winged and keeled by rather narrow ridges, on upper portion of stem these ridges run to next lower bud; three prominent bundle-scars. Stipule-scars somewhat conspicuous, narrow half-crescent shaped. *Buds.* Terminal buds broadly ovate. Axillary buds lanceolate with acute tips, 6–11×3–4 mm., reddish brown, appressed, not resinous or viscid.

Rumford Poplar

P. nigra (♀)×*P. laurifolia* (♂)

Summer Characters. *Stems.* Upper portion ridged, round toward base, very sparsely puberulose (almost glabrous) above, glabrous at base, growing tips covered with a slightly viscid aromatic secretion; brownish green toward tip, greyish green somewhat reticulate toward base; lenticels linear and white or brownish white toward tip, oval to circular and greyish brown toward base, 0.5–4.0 mm. long. Secondary shoots much less ridged, almost round, almost glabrous. *Leaves.* Broadly ovate, apex acute, base slightly cordate; firm, dark glossy green above, lighter green below; margin rather coarsely crenate, usually 2–2.5 crenations per cm., glandular; veins green above and below, midrib very sparsely puberulose on upper side toward base, glabrous below. Petiole flattened, oval, tinged with red and very sparsely puberulose above, green and practically glabrous below, lenticellate, 50–65 mm. long. Stipules broadly subulate, apex narrow acuminate, tardily fugaceous. Leaves of secondary shoots narrow ovate, apex acute, base rounded to acute; margin somewhat more finely crenate, usually 3–4 crenations per cm. *Buds.* Lanceolate, 6–10 mm. long, somewhat glossy, dark brown, slightly viscid, aromatic, appressed.

Winter Characters. *Stems.* Rather strongly ridged toward tip, round toward base; greenish brown toward tip, olive green and coarsely reticulate toward base; lenticels brownish to pinkish white, linear toward tip, elliptical to circular toward base; pith five-sided, brown, homogeneous. Leaf-scars triangular with apex sufficiently long to appear more or less equilateral, decurrent, winged and keeled by narrow ridges which extend to the next lower bud except near base of stem, three prominent bundle-scars. Stipule-scars prominent, curved-linear to narrow half-crescent shaped, usually blackened. *Buds.* Terminal buds broadly ovate. Axillary buds lanceolate with narrow acute tips, 9–12×3–5 mm., dark brown, basal scale somewhat lighter brown; very slightly resinous, not viscid, somewhat aromatic, appressed.

The Strathglass Poplar, the Frye Poplar, and the Rumford Poplar are sister seedlings of *P. nigra*×*P. laurifolia*. A total of 377 seed-

lings of this cross were grown and 10 were included in the first selections of which these were later considered to be somewhat superior. All these seedlings were very uniform in general characters and appearance, with resinous buds and leaves somewhat glaucous beneath. They resemble the balsam male parent more than the female parent *P. nigra*. The three seedlings here described are to be identified and distinguished by several characters. In comparison with the STRATHGLASS POPLAR, the stems of the FRYE POPLAR are somewhat more strongly ridged toward the tip; the leaves are a trifle more cordate; the petioles are a duller red above; the upper side of the mid-rib and veins are slightly more puberulose; and the winter stems are generally a trifle more reddish or brownish colored. The STRATHGLASS POPLAR also develops fewer lateral branches than the FRYE POPLAR in nursery stock. The STRATHGLASS POPLAR is distinct from the RUMFORD POPLAR in its more persistent and less strongly keeled stipules, in the less appressed but more acuminate buds, and in its somewhat smaller leaves.

The RUMFORD POPLAR differs from its named sister hybrids in its more sparsely puberulose, almost glabrous, stems and in its darker green, broadly ovate leaves with acute apex and slightly cordate base. The petioles of the leaves are also longer and the margin is hardly undulate. The leaf-scars on winter stems are somewhat more decurrent and have a more strongly elongated apex.

ROXBURY POPLAR

P. nigra (♀) × *P. trichocarpa* (♂)

SUMMER CHARACTERS. *Stems*. Round, with low narrow ridges on upper portion, on occasional stems, ridges persisting toward base; sparsely puberulose, end of growing tip somewhat viscid and aromatic, reddish brown toward tip, greyish brown reticulate toward base; lenticels white and linear above, oval and light brown below, 0.5–4.5 mm. long. Secondary shoots round throughout. *Leaves*. Broadly ovate to oval, apex acute to short acuminate, base obtuse; firm somewhat glossy medium green above, light green below; margin quite coarsely crenate, usually 2–3 crenations per cm., glandular, somewhat undulate; veins green above and below, mid-rib very sparsely puberulose (almost glabrous) toward base, glabrous below. Petioles flattened, bright red and puberulose above (older leaves less bright red), green and practically glabrous below, 30–50 mm. long. Stipules subulate, sharp pointed, green, youngest with brownish tips, tardily fugaceous. Leaves of secondary shoots ovate to elliptical, apex acute to short acuminate, base obtuse to broadly cuneate, margin somewhat more finely crenate, usually 3–5 crenations per cm. *Buds*. Lanceolate, 6–10 mm. long, glossy, dark brown, viscid, aromatic, appressed.

WINTER CHARACTERS. *Stems.* Rather strongly ridged toward tip, round toward base, brown toward tip, grey toward base; lenticels greyish white, somewhat broadly linear toward tip, elliptical to circular toward base; pith five-sided, brown, homogeneous. Leaf-scars triangular, with strongly elongated apex, not strongly decurrent, winged and keeled by rather sharp ridges which extend to the next lower bud, three prominent bundle-scars. Stipule-scars prominent, narrow V-shaped usually slightly curved and blackened. *Buds.* Terminal buds broadly ovate. Axillary buds broadly lanceolate with short acuminate tips, 9–14×4–6 mm., rather dark brown, basal scale light brown. Somewhat resinous, viscid, aromatic, appressed.

The ROXBURY POPLAR can be distinguished from the three hybrids, the STRATHGLASS, FRYE, and RUMFORD POPLARS, which are of *P. nigra*× *P. laurifolia*, by its more brown-colored stems, broadly ovate to oval leaves, with acute to acuminate apex, cordate base and slightly undulate margin, and its more broadly lanceolate winter buds.

The ROXBURY POPLAR can be distinguished from the STRATHGLASS POPLAR and the FRYE POPLAR by its somewhat more flattened petioles; somewhat longer and darker brown winter buds; and leaf-scars with more elongated apex. The ROXBURY POPLAR differs from the RUMFORD POPLAR in having a more undulate leaf margin; less sparsely puberulose and brighter red petioles; and winter stems less strongly ridged at the tips. Further, the base of the stem of the RUMFORD POPLAR is coarsely reticulate.

ANDOVER POPLAR

P. nigra betulafolia (♀)×*P. trichocarpa* (♂)

The female parent, *P. nigra betulafolia*, is a variety of the European black poplar. This hybrid has been slightly susceptible to *Melampsora* rust but up to the present time it has not been injured by the disease.

SUMMER CHARACTERS. *Stems.* Round, with low, narrow ridges toward tip, very sparsely puberulose, growing tip viscid, aromatic; reddish brown toward tip, light olive green somewhat reticulate toward base; lenticels white and linear toward tip, light brown and oval toward base, 0.5–4.0 mm. long. Secondary shoots round, more densely puberulose. *Leaves.* Broadly ovate, apex acute, base cordate; firm, somewhat glossy medium green above, lighter green below; margin rather coarsely crenate, usually 2–3 crenations per cm., glandular, somewhat undulate; midrib and large veins green and sparsely puberulose above, green and glabrous below. Petioles flattened, in young leaves bright red with narrow strip of green on under side, in old leaves green with slight red on upper side, sparsely pu-

berulose, 30–50 mm. long. Stipules subulate, rather long pointed, green, fugaceous. Leaves of secondary shoots ovate, apex acute to acute-acuminate, base obtuse; margin somewhat more finely crenate, usually 4–5 crenations per cm. *Buds*. Narrow lanceolate, sharp pointed, 6–10 mm. long, glossy dark brown, somewhat viscid, aromatic, appressed.

WINTER CHARACTERS. *Stems*. Somewhat ridged and greyish brown toward tip, round and brownish grey toward base; lenticels greyish white, rather broadly linear toward tip, elliptical to circular toward base; pith five-sided toward tip, round toward base, light brown, homogeneous. Leaf-scars broadly triangular, decurrent, winged and keeled by rather sharp low ridges, which are rounded at the leaf-scar and extend to the next lower bud except at base of stem; three prominent bundle-scars. Stipule-scars prominent, linear, usually curved and blackened. *Buds*. Terminal buds broadly ovate. Axillary buds somewhat broadly lanceolate with narrow acute tips, 9–12×4–5 mm., light chestnut brown, slightly resinous, not viscid, somewhat aromatic, appressed.

MAINE POPLAR

P. tacamahacca candicans clone BALM OF GILEAD (♀) × *P. berolinensis* (♂)

Both parents of this hybrid are members of the balsam poplar group. The BALM OF GILEAD is a variant of the northern balsam poplar, *P. tacamahacca*, which has been cultivated as a clone.

SUMMER CHARACTERS. *Stems*. Round, most vigorous shoots very slightly ridged toward tip, puberulose practically to base, greenish brown toward tip, greyish green somewhat reticulate toward base; lenticels white and linear toward tip, oval and brownish (or pinkish) white toward base, 0.5–5.0 mm. long. Secondary shoots round, not at all ridged, less sparsely puberulose, more red. *Leaves*. Ovate, apex acute, occasionally almost acuminate, base obtuse to slightly cordate, firm, medium green above, light green below; margin rather coarsely crenate, usually 2–3 crenations per cm., glandular, undulate; veins green above and below, midrib and lower parts of large veins sparsely puberulose above, extremely sparse below. Petiole slightly flattened, rather bright red and puberulose above, green and very sparsely puberulose below, lenticellate, 32–44 mm. long. Stipules subulate, green, sharp pointed, fugaceous. Leaves of secondary shoots ovate to narrow ovate, apex acute, base obtuse to cuneate; margin a trifle more finely crenate, usually 3–5 crenations per cm.; veins usually more sparsely puberulose. *Buds*. Lanceolate, sharp pointed, 6–10 mm. long, glossy, dark brown, somewhat viscid, aromatic, appressed.

WINTER CHARACTERS. *Stems*. Round, slightly ridged and brownish grey

toward tip, grey toward base; lenticels greyish white, rather broadly linear toward tip, elliptical to circular toward base; pith five-sided, brown, homogeneous. Leaf-scars very broadly triangular, somewhat decurrent, winged and keeled by low ridges, these ridges are rather sharp except at the leaf-scar where they are rounded, and on upper portion of stem they extend to the next lower bud. Three prominent bundle-scars. Stipule-scars prominent, narrow half-crescent shaped, usually more or less blackened toward base of stem. *Buds*. Terminal buds broadly ovate. Axillary buds, broadly lanceolate with slightly acuminate tips, 9–14×4–6 mm., medium brown, appressed, not resinous or viscid.

SUMMARY OF THE SELECTIONS

The parentage of the ten hybrids here described, the number of sister seedlings grown, and the number which were propagated as first selections are summarized in the following tabulation. The parents which are in the black poplar group are indicated by *italics* and those of the balsam group by **bold face** type.

SELECTION HYBRIDS	PARENTAGE		TOTAL NO. SEEDLINGS	NUMBER OF 1ST SELECTIONS
FRYE	*P. nigra*	×**P. laurifolia**	377	10
RUMFORD	"	× "	"	"
STRATHGLASS	"	× "	"	"
ROXBURY	"	×**P. trichocarpa**	200	3
ANDOVER	*P. nigra betulifolia*	× "	209	1
GENEVA	**P. Maximowiczii**	×**P. berolinensis**	112	8
OXFORD	"	× "	"	"
ROCHESTER	"	×*P. nigra plantierensis*	145	1
ANDROSCOGGIN	"	×**P. trichocarpa**	5	3
MAINE	**P. Balm of Gilead**	×**P. berolinensis**	82	2

It will be noted that the FRYE, RUMFORD, STRATHGLASS, ROXBURY, ANDOVER and ROCHESTER POPLARS are hybrids between *P. nigra* or its varieties *betulifolia* and *plantierensis* and some member of the balsam group. The other four have balsam poplars for both parents. Nine different plants are involved as parents: three are black poplars; six are balsam poplars.

The ten hybrids which are now named represent but a small part of the hybridizations which were made and of which seedlings were grown. Thirty-four different poplars were employed as parents, including 3 white poplars, 5 aspens, 17 black poplars, and 9 balsam poplars. About 13,000 seedlings were grown. Of the various groups of hybrids, 27 were most

promising; for these the total number of seedlings grown was 4,309; the number in a group of sister seedlings ranged from 5 to 705, and there were 14 groups of 200 or more each. From each of these 27 groups, "first selections" were made of from one to ten plants (a total of 69 seedlings) for propagation and special study.

Further selection among these seedlings was based on performance in Maine, chiefly while under nursery propagation. Final judgement of individual merit must be based on behavior in forest plantations. These ten hybrids may not be the best of the seedlings for use in warmer climates where the growing season is longer than in Maine. A test planting of the 69 first selections is now being grown at Strathglass Farm near New York City where the season of growth is several weeks longer than in Maine and where there was slight rust during 1932 and 1933. Here several others of the first selections have surpassed the named hybrids in vigor of growth. It may be mentioned that certain of the hybrids which were most vigorous during the early years of this study later suffered severe injury from the *Melampsora* rust. This was especially true of hybrids having *P. balsamifera virginiana* and *P. trichocarpa* as the parents. Various hybrids of the white poplar group which show vigorous growth may be of value for the production of match wood, which is a feature in reforestation efforts in various sections in Europe. Certain hybrids with columnar habits of growth and others of dwarf size may have value as ornamentals.

Since cuttings of these ten hybrid clones are being distributed rather widely for trial culture, it may be well to state that the above descriptions are the first that have been published for these individual clones and also that herbarium specimens and photographs of them have been deposited in the herbarium of The New York Botanical Garden.

INDEX TO AMERICAN BOTANICAL LITERATURE
1931–1934

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

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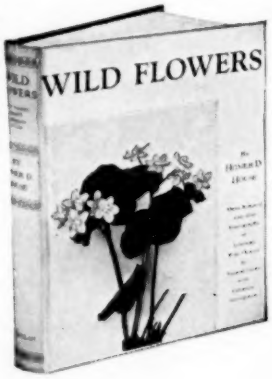

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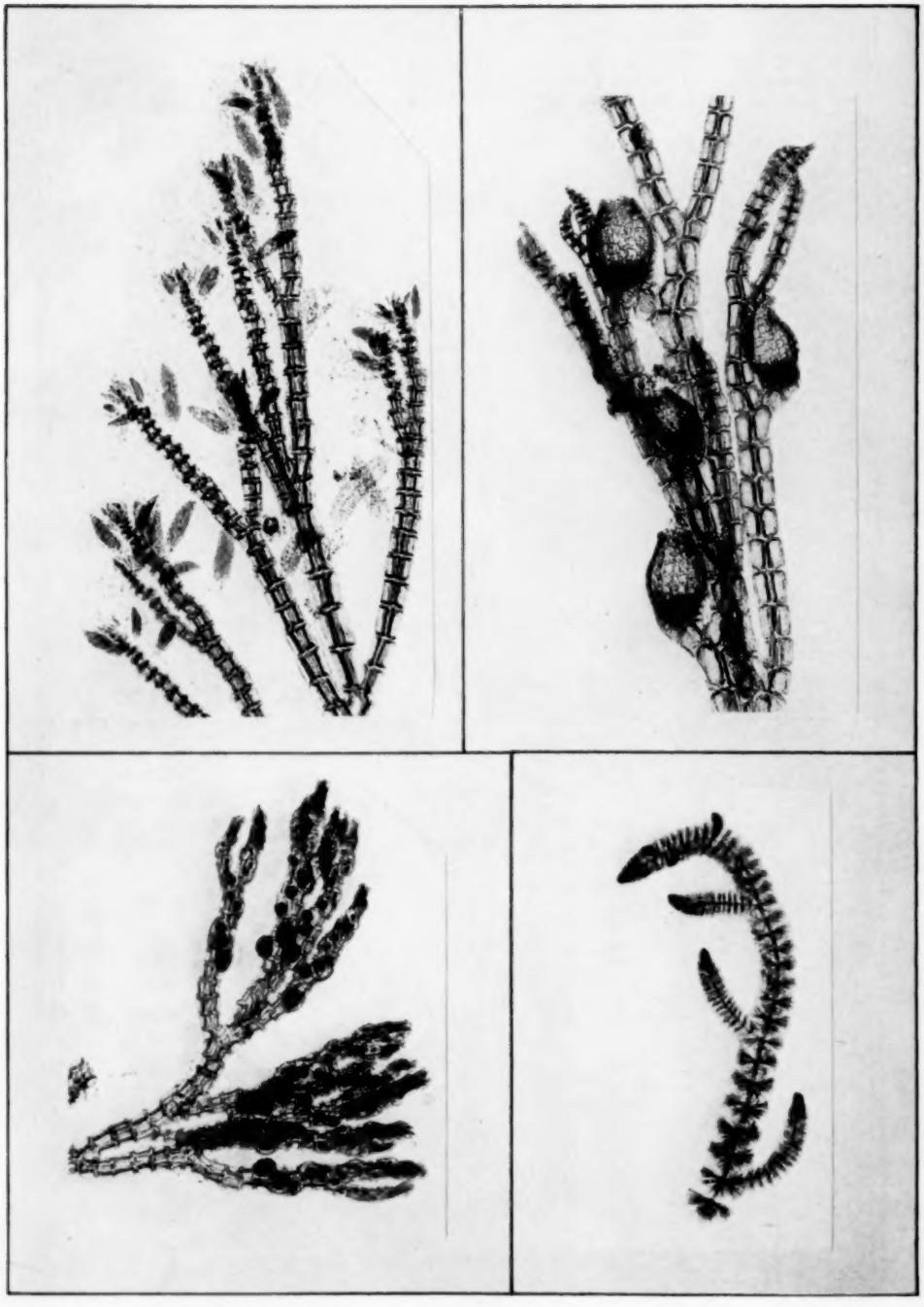

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